Physiology for Practical Use

EDITED BY

JAMES HINTON

PHYSIOLOGY FOR PRACTICAL USE.

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BY VARIOUS WRITERS.

EDITED BY JAMES HINTON,

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CONTENTS OF THE SECOND VOLUME.

	PAGE
Chapter I.	
Taking Cold	1
Chapter II.	
Influenza	26
Chapter III.	
Headache	38
Chapter IV.	
Sleep	53
Chapter V.	
Sleeplessness	80
Chapter VI.	
Ventilation	93
Chapter VII.	
The Liver and its Diseases	113

Chapter VIII. PAGE

The Action of Alcohol 125

Chapter IX.

Muscular Motion as Exemplified in the Human Body . 156

Chapter X.

Occupation and Health 178

Chapter XI.

Training and Gymnastics 199

Appendix 223

Index 229

PHYSIOLOGY FOR PRACTICAL USE.

I.

TAKING COLD.

To say, "I have taken cold," or "I have caught cold," is, in strict language, inaccurate. In the first place, natural philosophers tell us there is no such thing as cold; it simply implies in an arbitrary manner a low degree of heat. An atmosphere which feels cool to some persons is not so to others. In the next place, by taking cold, one intends to express that the body is affected by a definite set of symptoms, for which the phrase is not appropriate.

We do not say, "I have taken heat," or "I have taken damp," although these influences produce disease as well as cold. Nevertheless, the expression in question is sanctioned by usage, and is well understood, since every one in his own person has experienced the symptoms which go to make up the condition of having *a cold*. The affection is termed *a cold* because no cause

develops it more frequently than sudden or prolonged exposure to a low temperature when the body is insufficiently protected.

To understand how this happens, it will be necessary to remind the reader of the structure of the human skin. Every square inch of skin is perforated by several thousand openings, which are the apertures of corresponding glands by which the perspiration is separated from the blood. The quantity even of the insensible perspiration is very great, and it will surprise many to hear that, in the healthy state, it amounts to more than two pints in twenty-four hours. Under the influence of exercise or of unusual heat, such as that of the Turkish bath, when perspiration drops from the body, it is, of course, considerably greater. The skin, owing to its structure, possesses a contractile power in a high degree.

Cold contracts almost all substances, and when the skin is exposed to its influence the contraction becomes visible to the eye, and the appearance it presents is called *goose-skin,* from its resemblance to the natural condition of the skin of the goose. Occasionally the effect of the contraction is to close rigidly the perspiratory pores, by which the escape of the secretion is obstructed. This, so far as we know, is the essential cause of what we call *a cold.* It seems that the fluid, having been checked in its natural outpour, is diverted

inwardly upon the mucous surfaces of the body. Between these surfaces, which line all the internal parts which have any connection with the outer air, and the skin or covering of the external parts, there is a close relation, which is sometimes expressed by the term *sympathy*. Thus, it is well known that in many persons certain substances, which act as irritants to the stomach and bowels, cause irritation, and even eruptions, on the skin. Worms in children cause itching of the entrance to the nostrils; shell-fish, cucumber, and many other articles, produce in some persons eruptions on the face. In the latter instances, it may be objected that the noxious agents act by affecting the blood, but in many cases there are reasons for believing that the effect can only be that of indirect, or, as it is scientifically called, *reflected* irritation.

This internal skin, then, or *mucous membrane*, properly so called, is very prone to be affected by causes which derange the natural action of the outer skin. But the mucous membrane is itself provided with glands which secrete its mucus or natural moisture; for in a state of health this, in many situations, such as the nasal cavities, is all that is required, and therefore all that is present. But when the mucous membrane of a part secretes fluid in excess, and a defluxion is established, the affection is termed *catarrh*. This word is a Greek com-

pound, denoting an increased flow; and it is probable that none of the mucous membranes are exempt from its occurrence from some cause or other.

Cold in the head is by far the most frequent result of taking cold, regarded in a general sense. It may be well to describe briefly the symptoms of this common disorder; but it is desirable first to explain the nature of the parts affected.

The interior of the nose consists of a cavity separated into two equal parts by a thin partition of bone, which passes from before backwards, and which is continuous with the fleshy part of the partition seen at the entrance to the nostrils. Attached to the outer wall of each cavity are three thin convoluted pieces of bone, arranged one above the other, and also extending from before backwards. All these bones are covered by mucous membrane, and one use of the convolutions is to increase the surface exposed to the air, so that the odoriferous particles or vapours may thus affect the nerves of smell, which are distributed over the membrane. Now these cavities of the nose, besides other connections, communicate with the mouth and throat behind, and above with certain cavities in the front of the skull, which act as sounding-boards in giving clearness to the voice; and these cavities are also lined with mucous membrane.

The first symptoms of cold in the head are a sense of tightness or fulness in the nose and forehead, corresponding with the position of the cavities in the skull already described. The person sneezes, and his eyes become suffused. There is a general sense of discomfort, and disinclination for exertion. The skin is dry, and the pulse a little quicker than usual. The patient is, in short, somewhat feverish. If the interior of the nose be now examined, its surface will be found hotter and drier than natural; it looks redder, too, and tumid, from containing an excess of blood. The tumidity of the mucous membrane causes a sense of obstruction to be felt, and the voice is frequently affected from interference with the free connection between the nose and the frontal cavities. After this state of things has continued for a day, or longer, moisture begins to exude from the mucous membrane of the nose. This moisture is often at first thin and clear, like water; it is not pure water, however, but contains several ingredients, of which common salt is one. It frets and causes a sore eruption on the surface of the upper lip, over which it trickles during sleep.

After two or three days, the nature of the discharge in general alters. It thickens, becoming rather opaque and very viscid. In children, it is now often more or less purulent—that is, yellow or mattery.

Every one knows that although this discharge is inconvenient, and that the use of the pocket-handkerchief comes to be an absolute necessity, it is soon attended by relief. The sensation of tension in the head ceases, the skin begins to resume its proper functions, and the slight disturbance of health gradually lessens. But the time in which a cold in the head runs its course is very variable. Some persons get rid of such a cold in a few days, while others, from some peculiarity of constitution, retain it very much longer. A good deal depends, too, on how it is treated, and certain plans have been proposed by which this troublesome enemy can be more or less successfully combated. Not to mention many medicines, of which one of the most efficient is opium in some form,—but for the use of which it is always better to seek proper advice,—there is a particular method of treatment, once in much vogue, which, although troublesome, is sometimes very successful. It consists in abstaining as much as possible from drinking any liquids. By this means the supply of fluid to the blood, which goes to keep up the discharge, is cut off, and with it the discharge itself. In this way a bad cold in the head may sometimes be cured in a single day.

An equable temperature also conduces towards recovery. It is always desirable in winter to remain a

few days altogether within doors, and to keep one's apartment at a constant heat of about 65° Fahrenheit. This gradually induces the skin to perspire, by which its sympathetic friend, the mucous membrane, which has been trying, however imperfectly, to do the work of its neighbour, is relieved from its efforts. Sometimes, and especially at the very commencement of a cold, a forced action of the skin, by which it is made to sweat profusely, succeeds. This may be effected by internal medicines, aided by hot drinks, while the body is well covered with bedclothes. But a far more effectual sudorific is presented to us in the Turkish bath. The patient should expose himself to a heat of from 130° to 150° Fahrenheit for not less than an hour, and in this case the cold douche generally used after the bath should be dispensed with, and tepid water used instead. The object in view is not only to cause the sweat-pores to relax their orifices during the process of sweating, but to remain relaxed afterwards. Cold water dashed against the skin would tend to produce the contrary effect.

Cold in the head was known to our ancestors by the name of *the pose*, and *to pose* is still used in the sense of to stupefy. The term was evidently given to the disorder from the lassitude and indisposition for one's accustomed work which accompanies it. How slowly and by what painful steps knowledge advances! Only

two hundred years ago, the real source of the discharge from the head which accompanies a cold was described by Schneider. Before his time, the discharge was thought to come from the brain! In anatomical language, the internal lining of the nose has ever since been termed *the Schneiderian membrane*.

It has been held by certain writers that what is called disease is the expression of a beneficent design, as much as the adaptation of organs to their particular functions. They point to the eruptions on the skin in small-pox and like diseases as being the means adopted by nature to throw off from the blood, which alone sustains life, some noxious element which had gained access to it. They tell us that in other cases in which no curative effort is obvious, it is because of our ignorance in interpreting nature. They assert that when death occurs from disease, it is an accident incidental to the process to which the vital power succumbs. Now, whether this is true in every instance or not—and the proof is at present impossible—it seems in some instances well borne out. In this very case of cold in the head, we see suppressed perspiration, followed by febrile disturbance of the system, together with retention of materials in the blood which should have been thrown out. This is succeeded by a discharge from the nostrils containing the same salts as those ex-

creted in perspiration, which are thus in a vicarious manner expelled from the blood, and this continues until the disturbed balance is restored.

People often say when they have a cold in the head that they have got influenza, and, on the contrary, this is sometimes mistaken for a simple cold. But the two affections are quite distinct in origin as well as in effects. It is true that many of the symptoms are alike in both, except that they are all generally much more severe in influenza. It is commonly attended by headache, discharge from the nostrils, great languor and depression, followed not unfrequently in the aged and the weakly by death. Influenza is, in fact, a very serious and often a fatal disease. It was described more than two thousand years ago by Hippocrates, the father of medicine, himself. Truly an epidemic, many of its visitations to this country in former times can be accurately traced. These are fortunately not very frequent, and have not usually lasted more than a month or six weeks at a time. Many theories have been advanced to account for influenza. Some have attributed it to a disturbance in the electrical condition of the earth and the atmosphere. One authority went so far, from confidence in this view, as to recommend the use of socks made of oiled silk, or

some other non-conductor of electricity, as a means of guarding against an attack. Others have supposed it to be caused by some peculiar miasm in the atmosphere, which, travelling over the earth, accounts for the remarkable manner in which, like cholera, influenza passes from one country to another. But these and other theories are altogether deficient in proof. As in many other things connected with disease, we must for the present admit that we do not know its cause, and be content to wait until patient investigation throws light upon our darkness.

One thing, however, we do know, namely, that while the origin and progress of cholera and influenza have much apparent resemblance, both are also capable of being communicated by infection.

There is another affection, far more prevalent than is supposed, which is sometimes mistaken for a common cold. It is curious that many substances which have no effect whatever on people in general, act most injuriously on the air-passages of a few. Thus, some persons are at once affected with sneezing, and other signs of catarrh, whenever powdered ipecacuanha is exposed to the air near them, and even linseed meal sometimes acts in the same manner. But of all the causes which produce this kind of irritation, none is

so widely diffused as that which is derived from our hay-fields in summer. It is now pretty generally known that the emanations from hay injuriously affect a considerable number of people in a variable degree. Some complain merely of symptoms like those of cold in the head and eyes, while in others a severe asthma is produced. Whether these effects are due to exhalations, or to minute particles given off by the hay plants, is not certain. Whichever it may be, one plant in particular, the sweet-scented vernal grass, *Anthoxanthum odoratum*, has been accused as the chief, if not the sole, offender in the matter.

It too often happens that the effects of *taking cold* are not confined to the nose and its appendages in the front of the head. This might be expected, when it is considered that the connections of these portions of mucous membrane with others are very extensive. There are minute tubes lined with this membrane, which pass from the inner edges of the eyelids, where their little apertures can be distinctly seen, to the interior of the nose. The use of these tubes is to drain off any superfluous moisture from the surface of the eyes. The nose, too, communicates with the throat, and from the throat other tubes extend to the interior of the ear. All that concerns the ear and its appendages is treated of in its proper place. It is enough

here to indicate that this continuity of structure leads to the same affections of the parts concerned. When a cold in the head is severe, it is very apt to affect the eyes; and when the ear-tubes are obstructed from pressure of adjoining parts, which have become swollen from inflammation, deafness is caused.

The mucous membrane of the throat also communicates not only with the gullet, or passage which leads to the stomach and bowels, but by another avenue which descends for some distance by the side of the gullet to the lungs. This is the windpipe, by which the constant renewal of air in the lungs is effected.

It often happens, then, that the inflamed condition of the nose extends to the throat, which is felt stiff and slightly sore in the act of swallowing. The tonsils, or glands which stand out at each side of it, become enlarged. The inflammation is also now very liable to extend more or less into the windpipe. But the disorder does not always advance in this particular manner. Not only are the nose and its immediate appendages sometimes alone attacked, but at other times catarrh affects the throat alone, at others the windpipe only. Now, whenever the latter is affected, we have cough produced in addition to other symptoms.

Cough indicates irritation in the air-passages of the

lungs. It is caused by a peculiar convulsive motion, though the same result can be effected voluntarily, by which the muscles of respiration are made to expel forcibly a portion of the air in the lungs. The immediate cause of cough, as is well known, is a sensasation in the windpipe, for which it is the natural relief. Children call it *a tickling in the throat;* and it is a fact no less interesting than curious, that whatever part of the lungs is affected, as for instance when the lower lobe of one lung only is inflamed, the local irritation is reflected, telegraphed, so to speak, always to the same spot. This spot is situated where the windpipe divides into two branches, which go to either lung, corresponding with the root of the neck in front. To this appeal, cough, either as a single effort, or as many efforts constituting a fit of coughing, is the response. In this way the most distant parts of the lungs are relieved, for, as shall be presently explained, coughing is of itself a salutary act.

What a beautiful provision, and clear evidence of design, is seen in this circumstance! Let it only be considered how intolerable would be an irritation in the lungs, deeply seated within the body, if the lungs were themselves possessed of the same kind of sensibility as that which a small part of the windpipe possesses.

It is easy to see that the *use* of coughing is to free the lungs from fluid which would otherwise choke them, and speedily cause death, by interfering with respiration. On the other hand, this outpour of mucus relieves the congested lining of the air-tubes, just as the discharge in a cold of the head relieves the interior of the nose. Anything which is foreign to the air-tubes will produce cough, as well as an excess of mucus. It sometimes happens that such things as a bean, a small bone, or piece of money held in the mouth, gain admission beneath the valve placed at the top of the windpipe for its protection. This produces an intense fit of coughing, and the foreign body has not unfrequently been expelled by this means. One of the most familiar examples of cough produced in this way, is when a portion of our drink *goes the wrong way*. This is invariably attended by a suffocating cough, by which the liquid is thrown out with much force.

We have now explained how a cough is a secondary product of a cold, although the terms are often used to express the same idea. But, in reality, the cough is nature's mode of relieving us from the effects of the cold.

As a cause of disease, *taking cold* has a far wider significance than is implied in its effects as already

described. These are the most common, and have therefore been first explained. But in many instances the action of cold is more extensive and far more serious. A chief part of this action consists in the undue abstraction of animal heat. If this be for some time removed more rapidly than it can be supplied, the effects upon the vital organs are apt to be calamitous. Inflammation of the lungs, acute bronchitis, etc., are often thus induced when a man falls into water in winter, or when he has the misfortune to be put to sleep in a damp bed. In such cases the danger is always in proportion to the state of his system at that particular time. If the person be fatigued by want of rest or over-exertion, or weak from want of food, or in any way out of health, the risk is much greater. The reason of this is, that the nervous power by which the circulation of the blood is sustained and controlled is then deficient. And the result is, that the vital fluid retreats from its more superficial channels, and accumulates in the lungs and other internal organs. Congestion—that is, a condition of excess of blood in the parts—ensues, and this is the first step towards inflammation, which, as already said, is in vital organs, under such circumstances, no unfrequent sequel.

Another serious, although seldom fatal, effect of cold,

is chronic rheumatism. Repeated checks to the perspiration, and undue abstraction of heat from the body, produce in it a condition of pain and swelling of the joints, which in some instances make life itself a burden. Fishermen, and others, who are liable to have their clothes wet through without the power of changing them, are very subject to this disease.

What are the best means to avoid taking cold? Some may be inclined to say, "Avoid all exposure to its causes; never go out in wet or damp weather; never lie in a damp bed; never become overheated by exercise," etc. Now, even supposing these precepts could all be attended to by people in general, which is manifestly impossible, it will be found that, as often happens, error is here mixed up with truth. It is quite certain such a course would not be the best preventive, because it would inevitably induce a delicacy of constitution that would increase the tendency to be affected by cold. Even in the case of those whose means would permit of it, such a subserviency to the state of the weather, in our damp and variable climate, would become intolerable. We speak of those in good health; invalids must, of course, take exceptional precautions. No sane person would from choice sleep in a damp bed, or remain in clothes saturated with rain longer than he could avoid. But

it is in every respect desirable to meet the ordinary emergencies of weather by acquiring sufficient hardiness of body to resist them. It is a great disadvantage to be reduced to the condition of a green-house plant; an exotic in our native country, to which we ought to be acclimatised.

The horse affords a familiar example of how completely the animal constitution may be altered, and indeed impaired, by confinement and well-intended but injudicious care. It is necessary, for the sake of the sleekness of his coat and general appearance, that he should be housed. But his stable is generally much too warm, and is badly ventilated. The result is, that he is very liable to take cold when standing under his master's carriage in wet and stormy weather. Yet horses may be seen standing in the fields, and exposed day and night in all weathers, with perfect impunity.

In the same way as so hardy an animal as the horse is capable of being made delicate by artificial means, is man liable to the same result. The difference in the power of resisting the injurious effects of cold is as great between an effeminate person and a hardy sailor, as it is between a pampered horse and one whose only shelter is a hedge.

The best way, then, to avoid catching cold, although

it may seem a paradox, is not to be too much afraid of cold. Let one's accustomed exercise not be interrupted, because it is damp or even rains. Let these conditions be met by appropriate clothing, and let the feet be well protected by strong shoes. This rule must be observed, however; when one is out of doors, and the body feels cold from the clothes having become wet through, it is wrong to remain at rest. The danger of a sudden loss of animal heat has been previously explained, and this loss is then imminent.

Evaporation, although produced by heat, is very productive of cold, and it is greatly promoted by a current of air. It is on this principle that wine is often cooled for the table in hot climates. The bottles containing it are placed in a strong draught of air, while they are covered with a woollen material, which is kept constantly wetted. In this way wine can be obtained almost as cool as by means of ice. Now, in the case of a person whose clothes are wet and exposed to a gale, the conditions are exactly the same; instead of the warm wine, there is the warm body enclosed in a wetted covering. It is to be remembered, then, that the risk of catching cold from wet clothes is always greater in windy weather.

Cold may be taken, however, from moisture retained, as well as by that which is received. When perspi-

ration is profuse, it saturates the inner clothes, and its chilling effects are soon felt if the body is at rest. The best mode of avoiding this is to wear clothes of loose texture in hot and dry weather, so that the escape of perspiration may be promoted as much as possible. Flannel, which has been adopted by cricketers as the most appropriate dress for their active game, is admirably adapted for this purpose. For the opposite reason, waterproof clothing is very objectionable, except when absolutely required to resist rain. Any one who has worn it while taking exercise, will remember the uncomfortable state of dampness which it is sure to induce.

Many persons are extremely susceptible of cold from getting the feet wet or even damp. Fortunately it is in their power to guard against both by simple means; cork soles are very valuable preventives so far as concerns the bottom of the foot, and stout leather will insure sufficient protection for the remainder; but woollen socks, as being the best non-conductors of heat, and withal the least liable to retain perspiration, are in such cases indispensable.

When the lungs are delicate, and especially if a person has suffered repeatedly from bronchitis, the mere contact of cold air with the air-passages, even when he goes from a warm apartment into one of lower

temperature, has sometimes an injurious effect. In such unfortunate cases it may be necessary to submit to what is inevitable, and to wear a respirator when out of doors. The apparatus is so constructed that the entrance of air by the mouth is delayed, owing to its passage through a succession of close gratings of wire. In this way the air becomes warmed before it is taken into the lungs. In cold foggy weather this is especially useful. But we are convinced that the instrument is often unnecessarily employed. In such cases its use only tends to bring on the state of artificial delicacy already spoken of. Besides this, if the respirator be put aside even for a minute, as must happen to those who have business to transact, which requires the person to speak, the cold air then gaining access is more liable to irritate the lungs than if no precautions at all had been taken. The nose is, in fact, the natural respirator. One of the uses of its extended surfaces and tortuous passages, is to warm a cold atmosphere before its admission to the chest. Catlin, the traveller, to whom we are indebted for so much knowledge concerning the fast-vanishing tribes of North American Indians, published a small work, which he called "The Breath of Life." He observed that the Indians are above all things careful to breathe through the nostrils. He was so much struck by what he saw and heard

amongst them in reference to this matter, and its importance to health, that he thought it worth while to write a book on the subject.

There is a popular prejudice concerning the evil effects of night air, about which a word must be said. In her admirable writings on hygiene and the management of the sick, Miss Nightingale has done much to correct this mistake. It was formerly the universal belief that the air of night was very injurious. But the fact is, that, except under certain circumstances, it is as healthful, or even more so, than that of the day-time. The night air of large cities such as London, when the bustle and commotion, which cause it to be loaded with dust particles, is comparatively quelled, and the numerous fires which contaminate it with their smoke are mostly extinguished, is purer than that of the day. Nothing conduces more to healthy sleep than good ventilation, and no mode of ventilation surpasses that obtained by opening a window at the top, by which the influence of draught is avoided, while the upper stratum of air in the room, to which impurities ascend, is constantly renewed.

There is still another reason for at times adopting night, even in preference to day, ventilation. In sultry weather it is a common mistake to open the windows instead of keeping them altogether closed, as is the case

in hot climates. A little reflection will show that since the height of the thermometer in the sun always greatly exceeds that shown at the same time by another thermometer placed in the shade, by opening the windows we admit air much heated into our rooms. The proper time under such circumstances for ventilation is during the night, when the external atmosphere has cooled down. By adopting this plan in hot weather, the temperature of a room may always be kept several degrees lower than if the opposite course is pursued.

The influence of a draught in giving cold is sometimes exaggerated. It is seldom, indeed, advisable or even safe to remain long exposed to a strong current of air. But many persons are so much afraid of even a gentle current, that they deny themselves the advantages of ventilation. In considering the effects of a draught, two things are important. First, the temperature of the current of air. A cold current removes the animal heat unduly, and if it strikes the body in a particular part, not unfrequently causes local rheumatism. But the current will be innocuous if it be only warm enough. In the tropics, so far from avoiding, people try to get into draughts. Arctic voyagers tell us that it is only owing to the extraordinary calmness which prevails in the polar regions, that the extreme cold can be endured. Under the influence of a high wind, the most robust

would soon succumb. Here is a striking proof that the constant renewal of the air, when of low temperature, in contact with the body, very much increases its cooling effect. But if the atmosphere is itself as warm as the body, or nearly so, no harm can result.

Secondly, a draught through a small aperture is more dangerous than a more diffused one coming through a larger space. A Portuguese proverb says, "If you catch a cold from draught through a key-hole, you should make your will." A small current of air is the most rapid, and it is unnecessary to repeat the reasons why this is most likely to give cold. We are no advocates of the water-cure, or so-called hydropathy, indiscriminately applied. But it is the part of a wise physician to select from every system that which seems to him useful and true. Hydropathy has at all events made one thing popular, namely, that people do not necessarily catch cold from sleeping in wet bandages or even wet sheets if proper precautions are adopted. These precautions consist in placing a sufficient amount of dry clothing over that which is wet to prevent any chilliness from being experienced by the patient. Here is a principle not to be lost sight of; should it be one's misfortune to meet with a damp bed under circumstances in which no other is to be had, let all available

coverings be placed over it, or at least to the extent that the person who occupies it shall feel warm and comfortable. He may then defy the damp, and sleep in security.

In another part of this work a description is given of the Turkish bath and its uses. It only remains here to add, that perhaps no means of hardening the body against liability to taking cold is more valuable than the hot-air or Turkish bath. We have proved this practically in numerous cases. Nor is it difficult to understand how this is effected. The apertures of the sweat pores are thrown open by the high temperature of the bath, and while in this condition are suddenly, but only for the instant, closed by the cold-water douche with which the process of the bath ends. A bracing effect is by this means produced in the skin and its pores, by which the tendency to a more permanent contraction is prevented. No danger need ever be apprehended from the application of cold water, or even, as practised in Russia, of snow to the naked body, if it be made immediately after remaining some time exposed to a high temperature. If, then, the cold-water cure has taught us one important fact, at which probably we should not otherwise for a long time have arrived, the hot-air bath has instructed us in one no less important, and at which our ancestors

would have looked aghast. It is, that no danger of taking cold need be apprehended when the body, already bathed in perspiration, is immersed in the coldest water.

II.

INFLUENZA.

The disorder we have at present to deal with in many respects resembles a common cold, and under this head something has been said about influenza. A description of the local affections there given, is to a great extent applicable to influenza, and need not be repeated here. Indeed, a great mistake is often made in confounding the two affections. Perhaps it is that the prettiness of the name misleads; but this is certain, that true influenza is a much more serious malady than is generally supposed. The disease is an epidemic, and, fortunately, its visitations are not very frequent.

In the days when philosophers believed that things on earth were governed by the heavens, the present malady was attributed to the influence of the stars, and the Italians gave it the name of "Influenza"—pre-eminently the influence—and this term has been adopted into English. The *grippe*, or the *seizure*, the name by which it is known to the French, is more descriptive.

The primary symptoms of influenza are much the same as those of ordinary catarrh. The patient has a

sense of tension in the forehead; his eyes become watery, and he sneezes. Discharge from the nose, cough, and oppression at the chest, soon ensue. But the chief characteristics of influenza are a dull pain in the forehead, which is very oppressive, and an extraordinary prostration of strength, with mental depression, listlessness, indisposition for the least exertion, and utter want of appetite. The skin is generally moist, and the perspirations which occur are not critical, as they seem to be in certain cases of fever. As the disease advances, the discharge from the nose irritates the upper lip, so as to make it red and tumid; the sense of taste is in general impaired. The disease usually lasts four or five days, and, when it subsides, the patient not unfrequently finds himself as much weakened as if he had gone through a long fever. Weeks often elapse before he has regained his original tone and vigour.

Such is a sketch of influenza, as it generally shows itself; but it varies a good deal in different epidemics. Sometimes the symptoms do not exceed those of a common cold; at other times, in addition to severe headache, there are piercing pleuritic pains of the side, associated with inflammation of the lungs. Fever runs high, and there is nightly delirium. Under such circumstances, many patients are carried off. It is remarkable that the very young and the very old are less liable to

the disease than the strong and the middle-aged; but when the disease seizes the aged, or those debilitated by other diseases, they often die from its effects.

Influenza is a disease of depression, and requires supporting treatment. Centuries before it was discovered that the lancet could be almost altogether dispensed with, it was found that bleeding was deadly in this disease. "Where blood was let," says an old author, "the disease proved malignant and pestilential, being attended with a violent, cruel, and unheard-of malignity, and made bad work." We are told by the same author, speaking of the epidemic of 1557, that in the small town of Mantua Carpentaria, three miles from Madrid, where the disorder raged with uncommon severity, "two thousand were let blood of, and all died." In this account we have had a sad exemplification, not only of the danger of routine practice, but of the difficulty experienced in throwing off old traditions. Given a tradition that every kind of feverish excitement can be only treated successfully by withdrawing a portion of the vital fluid from the body, and the responsibility of breaking down the tradition becomes enormous. No one will dare not to bleed, lest the patient should suffer from the omission, and no chance is left for ascertaining that what is intended to cure in reality kills. We live in days enlightened by the mishaps and the experience

of the past, and from these we have learned that to husband and improve the quality of the vital fluid is the most successful treatment in all diseases accompanied by debility. Good beef-tea, then, with a fair allowance of generous wine, quinine, and other tonics, are the best remedies for influenza. Complications, such as inflammation of some important organ, require of course special treatment.

Unlike epidemic cholera, which seems to be of comparatively modern origin, influenza possesses a long lineage, and pierces the depths of antiquity. Hippocrates, the father of medicine, mentions the disease. In the "Annals of the Four Masters," an Irish manuscript of the fifteenth century, it is stated to have been epidemic in Ireland in the previous century. It was very fatal in France in 1311; and in 1403, the law-courts in Paris were closed on account of the deaths which it caused.

In the sixteenth century, epidemics were very prevalent in England. Sweating sickness and influenza at various times devastated the land. There can be no doubt, that to the habits of our ancestors, and the little regard paid to sanitary matters, the great mortality was mainly due. There is a curious letter extant, written by Erasmus to the physician of Cardinal Wolsey, in which this matter is touched with the hand of far-seeing genius. Erasmus says that he is grieved, and wonders how it hap-

pens, that Britain has for so many years been afflicted with continual plagues. He complains that the English have no regard to the aspect of their windows or doors, and that their rooms are so constructed as to be incapable of being ventilated. The streets, he adds, are covered with clay and rushes, which are so seldom removed that the covering sometimes remains for twenty years, and that beneath this covering is a layer of filth not fit to be mentioned; a most unwholesome vapour is exhaled from this. He adds, that it is his firm opinion that the island would become much more wholesome if the chambers were built so as to be exposed to the air on two or three sides, the glass windows being made to open. It would contribute also to health, he says, if more sparing diet was used and less salt provisions were consumed.

Happily we can make a cheering comment on this remarkable letter. Drainage, ventilation, and the food of the people have, since the time of Erasmus, been immensely improved, although finality in these matters has not by any means been reached. The results have, however, been most gratifying, as the bills of mortality prove. Certain epidemics, in obedience to some unknown laws, at uncertain intervals still sweep over the land, despoiled of much of their power. But the plague has been long unknown amongst us; typhus is almost

confined to those who are destitute of the ordinary comforts and conveniences of life; and, owing to the treatment having been at length better understood, joined with a better comprehension of the laws of life, influenza is now only exceptionally fatal. If, then, we have lately expended upon the drainage of London alone, the bewildering sum of seven millions sterling,—bewildering if any attempt is made to grasp the details of the huge outlay,—let it be some consolation to the householder, who is in consequence saddled with a tax that will more than outlast his own life, that he is paying for increased longevity. The length of life in England slowly but steadily increases. The incontrovertible reports of the Registrar-General prove this.

We are as much in the dark as to the real cause of epidemics as Hippocrates confesses himself to have been more than 2,000 years ago. Failing to account for them by any known physical agency, he attributes them, with a feeling of religion which does him honour, to Divine interposition. The great Sydenham also confesses his ignorance on this subject, but thought that they may be due to "some occult and inexplicable changes wrought in the bowels of the earth itself, by which the atmosphere became contaminated with certain effluvia which predispose the bodies of men to some form of disease." That influenza does not depend on weather is very

plain. It has broken out at all seasons of the year and when the temperature has been at both extremes, and it has advanced in a particular direction in the teeth of prevailing winds. Electricity, which, like the Gulf Stream, is called upon to account for many things with which it has nothing whatever to do, has been supposed by many writers to be the exciting cause of this disease. One thing which favours the idea of some such cause as electricity is the suddenness with which the disease attacks at the same time a large number of people. Several instances of this will be afterwards related. This suddenness of attack is sufficient to prove that influenza, even if it be infectious, which is doubtful, is not propagated essentially by infection. It is ascertained that a person who has suffered from influenza, derives therefrom no immunity from being attacked in a succeeding epidemic of the disease.

Influenza generally attacks a large proportion of the inhabitants of a country which it visits. Women are less liable to it than men, probably on account of their being less exposed to the weather. The ages between ten and sixty supply most cases. The low parts of towns are more seriously affected than the higher and better drained parts. There can be no doubt but that it is caused by a specific poison, which either emanates from the earth or pervades the atmosphere. One proof

that it is due to some general cause consist in this,—that it has been often observed that the lower animals have suffered from an illness more or less resembling it during the prevalence of influenza. Various strange natural phenomena have also been associated with it, but it is probable that in many of the cases these associations were merely coincidences. We shall afterwards mention some occurrences of the kind. Whatever may be the exact nature of the cause which produces the disease, it is certain that it progresses in definite directions. The East seems to be the home of epidemics. It is from that quarter that cholera travels, until it reaches the western countries. Influenza pursues a like course, and the ocean, as we shall see, presents no barriers to it. After having pervaded Europe, it usually passes over to America, beginning at the parts nearest to the Old World from which it started.

We possess details of many well-marked visitations of influenza. Some of the most remarkable were those of 1580, 1732, 1782, 1803, and 1836.

The epidemic of 1580 was very severe. Great numbers were destroyed by it all over Europe. In England it was preceded by earthquakes, and a comet also appeared. Other prodigies are mentioned in connection with it. A prodigious number of insects, supposed to rise out of the earth, filled the air; but, most strange of

all, "in Kent and the marshes of Essex was a sore plague of strange mice suddenly covering the earth, and gnawing the grass roots. . . . No wit nor art of man could destroy these mice, till another flight of owls came and killed them all. A great earthquake in Peru." Such is the curious mixture of truth with exaggeration which our annals contain.

The epidemic of 1732 made its appearance about the middle of November in northern Germany, and before the end of February, 1733, had reached Naples and Spain, having in the meantime overrun all Europe. In the middle of the following October it arrived in New England, and thence turned southwards to Barbadoes, Jamaica, Mexico, and Peru.

The epidemic of 1782 was traced from India, where it seems to have prevailed in October, 1781, to have reached Moscow in December of the same year, and St. Petersburg in the following January. It was in Denmark in the latter end of April, and arrived in London by the second week of May. This epidemic arrested great attention, both on account of its severity and its almost universal diffusion. A great many persons died from it.

The following incident, which occurred at this time, shows that the poison of influenza probably advances like a wave, and thus at once involves whole communities.

The occurrence also proves that, as already said, infection is insufficient to account for its propagation. Captain Kelly, of the *Fly* sloop of war, weighed anchor about ten in the morning, with a crew of 145 men; but before six the same evening, forty were laid up with influenza, and he was obliged to return to Yarmouth Roads the next morning through want of hands to navigate the ship. Several of the men fell at the wheel and were carried below, and not a single man on board escaped attack.

Another marine incident in this epidemic is to the same effect. On May 2, Admiral Kempenfelt sailed with a squadron from Spithead. On the 29th of that month the crew of one of his vessels was attacked with influenza, and the others suffered in succession to such a degree, that the whole squadron was obliged to return to port early in June. They had, in the meantime, cruised only between the coasts of England and France, and no communication with any land had been held. About the same time another large squadron, in perfect health, sailed from Holland under Lord Howe's command. The disease broke out in this fleet just at the same time as it did in the one previously mentioned, although in the last case also no intercourse had been held with land.

It is related by Kirkby and Spence, in their "Entomology," that the brown-tail moth that year occasioned such devastations in the neighbourhood of London, that

rewards were offered for collecting the caterpillars, and that it was the duty of overseers of parishes to see them burnt by bushels.

In 1803, the British Islands were again invaded by a very severe epidemic of influenza. It came to us from the Continent, as on previous occasions. It commenced in London, and in about three months was generally diffused over England. Horses, cows, dogs, and even cats, were attacked with an analogous disorder, and many were carried off. On April 26, a remarkable meteoric shower occurred at L'Aigle in Normandy. The stones were counted by thousands, and the largest weighed $17\frac{1}{2}$ lbs. The sheep-farms of Tweedale were devastated by caterpillars, which devoured the grass. Red rain and snow were observed to have fallen in many parts of the south of Europe. The reddish dust which caused this appearance contained eighteen species of animalcules. Dr. Darwin states that "the sun was many weeks obscured by a dry fog, and appeared red as through a common mist." He adds that "the material which thus rendered the air muddy, probably caused the epidemic catarrh which prevailed in that year."

The last well-marked epidemic of influenza broke out in this country in 1836, and lasted about four months. The disease occurred in a severe form, and it was calculated that three thousand persons died of it in Dublin,

besides those who, although they got over the immediate attack, sank under diseases induced by the epidemic. It was coincident with cholera, into which it passed in many instances; for during this year that much-dreaded disease returned, after a short interval, to our shores. An epidemic also prevailed amongst cattle and sheep.

Much more might be written of the history and nature of influenza, but enough has been said to show that a disease, in the name of which there is something mild and euphonious, is in reality a fierce and too often a dangerous visitor.

III.

HEADACHE.

It is a rare thing to find any one who does not occasionally suffer from headache. In its minor forms it is a very common disorder. But headache is not always in any sense a trifling ailment. Too often it is a very severe one, and occasionally portends serious mischief.

The nature of pain is discussed elsewhere in this work. At present we have to deal with pain localized in the head. And since this pain exists in close proximity with the brain, the centre organ of the nervous system by which the mind works, we learn why it is that headache, in relation to its severity, causes more constitutional disturbance than other kinds of pain, and also why it is so frequently accompanied by mental dulness and confusion.

There are good reasons for believing that the pain is seldom, if ever, seated in the brain itself, while it is clear that in many cases it is external to it.

This strangely-formed, white, pulpy, mysterious mass, possesses no common sensibility. If exposed by the destruction of a portion of the skull, as has sometimes

occurred in the human subject, it may be touched with impunity. If it be strongly pressed upon, the result is not pain, but total unconsciousness so long as the pressure is continued. Inflammation of the membranes by which the brain is protected—and it is enveloped in no less than three of these, one within the other—is, however, attended by severe pain. We must look for the seat of ordinary headache in the nerves which have their origin in the brain, and which radiate in all directions about the head.

Headache is, perhaps, always symptomatic; that is, dependent upon and indicative of some other affection. But as it is often the most marked and distressing symptom present, it happens that it is often looked upon and treated as the main disorder.

Headaches are due to various causes, and for the present purpose the best classification will be one founded on this circumstance. It will suffice to describe only those kinds most commonly met with, and which will prove with so many readers to be old acquaintances. These are—

Headache from indigestion, popularly called *sick headache*.

Nervous headache.

Headache from fulness of blood in the head.

Rheumatic headache.

The well-known sick headache is not confined to any particular sex or constitution, but belongs especially to the early years of adult and to middle life. Some persons are much more subject to it than others, while a few seem to be entirely exempt from the disorder. It is, however, the penalty which a large proportion have to pay for any unusual indulgence of appetite. This headache is often preceded by a sense of chilliness: while the feet are cold, and face and forehead are flushed and hot. A dull heavy pain, with a sensation of weight and fulness, is experieneed in the fore part of the head. The temporal arteries throb with violence, and this throbbing is felt in the pain. Sometimes the pain moves into one temple, or into the eyeball of one eye. The patient is generally very irritable, and light and noise increase his suffering. He seeks darkness and silence, content to suffer in solitude. There is total want of appetite—nothing but perhaps a cup of tea is taken throughout the day during which the attack continues. Distressing nausea and a sense of rising in the stomach greatly aggravate his suffering. At length this ends in vomiting, attended by violent straining. The contents of the stomach, which are first discharged, are often found but partially reduced, although they have lain in the organ long beyond the usual period required for complete digestion. Afterwards a viscid

and intensely disagreeable fluid is alone ejected; and if the vomiting be further continued, bile is at last brought up. This bile was not, however, present in the stomach until the violent straining had been communicated to the adjoining portion of the intestine into which the bile is discharged from the gall-bladder. At first the act of vomiting greatly increases the headache. The return of blood from the head is impeded by the muscular straining, and already more blood than usual is lodged within the skull. But as soon as the stomach has got rid of its acrid contents, and the vomiting ceases, relief is experienced. Sleep, that best of all restoratives, now comes on, and the patient awakes after some time, still somewhat exhausted, but free from pain.

Such is a description of a common form of suffering. It is called sick headache from its constant association with disordered stomach. What, then, is to blame for its occurrence; and how is it to be averted? In a certain number of instances the answer is easy, and the remedy almost as easily applied, by avoiding those articles of diet which each person has learned from experience are injurious to his stomach. There is hardly any individual who has not discovered that certain articles must be regarded by him in this light, and the older he grows, the more he finds it necessary

to add to the list. "A man is either a fool or a physician at forty," was the memorable saying of a Roman emperor, in reference to this very matter. No general rules are applicable, because the proverb, "What's one man's meat is another man's poison," is also true. Still there are particular articles which very generally disagree with persons of weak digestion. Hashes and all rich highly-seasoned made dishes are of this class. Mixing up in the stomach along with a meal already too varied, ices, luscious sweatmeats and creams, as is commonly done, is always injurious. But quantity is no less to be considered than quality. A person may sometimes eat a little of a number of articles with impunity, while a greater quantity of a less number of articles would seriously disagree with his stomach. The man who, for the temporary gratification of eating more than he knows he can easily digest, and knowing too that if he does not so digest, he must suffer long afterwards, is without doubt a fool. A long chapter might be written on the folly of injudicious feasting.

Indigestion is of course not always attended or followed by headache. Many persons suffer terribly in the stomach without any trouble of the kind. It is only in those cases—and they are very numerous—in which the head is a weak point, in other words susceptible, that headache occurs. Now, there are two ways of ex-

plaining the mode in which headache is produced by in-ligestion, and there can be no doubt that both come nto operation.

First, there is an intimate and direct connection by neans of nerves between the stomach and the head. When, therefore, the nerves distributed over the internal ining of the stomach are irritated because they are in-volved in the general irritation of this lining, the mor-bid effect is transmitted to the head, and there makes tself known as headache. One form of the disorder, hat in which headache comes on *immediately* after ood has been taken, can be attributed to no other source.

Secondly, imperfect digestion tends to make the blood itself impure. Let it be remembered that the sole purpose of digestion is to supply the vital fluid with resh material for the support of the body. But if the blood be tainted by the absorption of ill-prepared nutri-nent, the brain, which is of all our organs the most easily affected by the circulation through it of impure blood, will suffer. In this way pain is developed, if not n the brain itself, in the nerves which it sends off, and which are so abundantly distributed in its immediate neighbourhood.

There is perhaps no more certain cause of headache han taking stimulants in excess, especially if different

kinds be indulged in. The well-known headache on the morning following the indiscretion is unquestionably due to impurities which the excreting organs have as yet been unable to separate from the blood.

It may be here remarked that the circulation in the brain of impure blood, from its having been supplied with ill-prepared chyle, in other words, with a solution of badly digested food, offers an easy explanation of other facts. It shows how the mind itself becomes dulled by indigestion—how the memory becomes impaired and the thoughts confused. It explains the groundless apprehensions and suspicions which haunt the morbid imagination of the hypochondriac. This also indicates how in most cases dizziness, dark images before the eyes, and numerous other head affections are produced.

There is a form of headache which seems to depend on indigestion, since it is attended by the same kind of stomach derangement as that described, in which the connection between cause and effect is not always easy to trace. Like the other, too, it is often called *bilious headache,* because bile makes its appearance, as already explained, in the vomited matters. People otherwise quite healthy are not unfrequently the subjects of it. It is sometimes strangely periodic in its attacks. A person will tell you, "I cannot keep such and such an engagement, because I shall have my headache on that

lay," yet the interval between the attacks may vary from one to several weeks. This may happen too when great care is taken in diet as well as in other respects. Yet indications are seldom wanting that the natural functions of digestion are previously disordered. This headache is usually preceded by constipation of the bowels, and a timely purgative will in many instances for the present ward off an attack. It seems, in fact, as if the unaided bodily machine was unable to keep going without derangement beyond a limited time. In most instances it is a very refractory disorder, and many of those who have been subject to it for a long period resign themselves to their fate; they simply seek for some alleviation by remaining in bed in a darkened room on the day during which generally the attack lasts.

Nervous headache is the kind to which persons of the nervous temperament are particularly subject. The outward characteristics of this temperament are not difficult to define. The form may be rounded, but is not muscular, the features are refined and impressionable, the spirits easily elevated and as easily depressed. There is great susceptibility both of body and mind, and yet both may be surprisingly equal to a great emergency. Hence it is that the softer sex is especially liable to nervous headaches, and the peculiar functions of the female organi-

zation increase this tendency throughout a great part of life. The consequence of all this is, that women suffer from headache much more frequently than men.

Like sick headache, nervous headache varies in severity. At times the whole mass of the brain seems invaded by throbbing pain, while at others the pain is much less acute and quite local. It more frequently attacks the upper and back parts of the head than sick headache. A great many physical causes will induce it, and few are more likely to do so than bad ventilation. It is this which makes going to a theatre with many persons equivalent to going to get a headache. The contamination of the atmosphere caused by its having been breathed and rebreathed by a large number of people, is partly the cause, and in addition the great number of gaslights unduly consumes the oxygen of the air, while the products of the gaseous combustion are poisonous. This is so sensibly felt by many persons that headache is sure to come on if they remain even for a short time in any gas-lighted room.

Particular states of the atmosphere at large are also very productive of headache. Many are affected when it is damp and foggy, others when it is dry and searching. The east wind is in this way an enemy to some. The climate of certain localities makes a great difference. We have known instances in which the comparatively

bracing air of Brighton could not be endured on account of headache. The more relaxing atmosphere of South Devonshire is equally injurious to others. The electrical state of the air has also a powerful effect. Some persons get headache at the approach of a thunderstorm, which, although they may be in bed at the time, they can foretell by this means alone.

The foregoing may be regarded as causes which in various ways disturb without exhausting the nervous power; but there is another set of potent causes which exhaust as well as disturb it—excitement, even of a pleasurable kind, in very susceptible persons; depression caused by grief, anxiety, or disappointment, night-watching, over-fatigue, long-fasting, and cold feet, are all well-known causes of headache.

As may be supposed, the causes which produce sick or bilious headache may be combined with those of nervous headache. The complication in such cases renders the disorder more intractable.

Hysteria is the cause of a singular form of headache. Spasmodic pain is first experienced in the abdomen, from which it extends to the throat and head. Sometimes the headache occupies a mere spot in some part of the head, and the pain is then very intense. It was from these circumstances that it was termed *clavus,* or the nail, by the old writers. By this is

intended to be expressed that the pain is like that which might be caused by a nail driven into the head. The suddenness of the attack is in these cases remarkable, and it subsides, usually after eructation of gas from the stomach, with equal abruptness.

Allied to nervous headache is that caused by residence in a malarious country. It is, in fact, one of the phenomena of ague, but the true ague fit may be entirely wanting. This headache is generally periodic, and attacks one side only of the head. Megrims is the popular name for a kind of headache to which women are more especially liable, and which, although intermittent, and often observing regular intervals, is caused by some kind of nervous exhaustion such as has been already described.

Headache from fulness of blood in the head affects those especially who are of the sanguine temperament and plethoric habit. Such persons are of stout build, they have red faces and short necks, and although commonly regarded as "pictures of health," too often present a deceptive appearance.

Nature has taken great pains to prevent congestion, that is, an undue accumulation of blood within the skull. But on this subject it would be out of place here to enter into details. It will suffice to say that the proper action of the brain depends on a properly

regulated supply of blood. Now, a disturbance of the balance occurs from two causes—either there is too much blood in the entire system, as sometimes happens in plethoric individuals, or else there is relatively too much blood in the head. Both conditions may give rise to headache, but the last is that which is far more common, and therefore concerns us most.

Many causes induce a determination of blood to the head in those predisposed to it. Violent passions and emotions of the mind, intemperance, heated rooms, long continuance of the stooping posture, etc., are amongst the number. But no cause is more productive of it than direct over-stimulation of the brain. Every literary man knows that if he works beyond a certain point, his head becomes hot and throbbing, his thoughts dull and confused, and if he still persist in his labours, headache is sure to follow. Now these results, it will be found, do not depend so much on the time during which the attention is occupied in a given direction, as upon the amount of work imposed upon the brain. Four hours' continuous reading will not have the same effect as if the same time had been devoted to original composition. Blood is the proper stimulus of the brain; and when it is in an active state, and thoughts are being elaborated, it contains more blood than when in the comparatively passive

condition of comprehending the thoughts evolved by the brains of others. The immediate cause of sleep, which, when sound, implies total inaction of the brain, is that the brain becomes comparatively bloodless; when, on the other hand, the brain is most active, it contains most blood. Here, then, is a matter for the serious consideration of all who live by their brains. The delicate organ gives a timely warning of overwork in the headache which it causes. And if the brain be habitually ill-treated in spite of warnings, there is great danger of the congestion becoming permanent and the headache chronic.

Rheumatic headache differs from the other kinds described, in its cause, its nature, and in the parts affected. It always proceeds from exposure of the head to cold; the pain is dull and heavy, and is always worst at night. It affects both the front and the back of the head, and is apt to shift about. It is seated in the muscles of the head, and affects especially their tendinous structures, and the painful parts are very tender on pressure. But there is neither heat nor throbbing; on the contrary, it is often accompanied by a sensation of cold. This form of headache belongs to the rheumatic constitution, and usually attends those who have suffered from rheumatism in other parts of the body.

As for the more inveterate and fortunately more rare forms of headache, dependent on organic disease of the brain, we do not at present take them into account.

It will be well to say a few words in conclusion, as to the prevention of, and the simpler remedies for, headaches. In every case, however, in which the attack is violent and repeated, skilled advice should be sought. We have already said that headaches are symptomatic, and no time should be lost in ascertaining the real seat of disease.

As for headaches dependent on indigestion, we may once more say, that attention to diet is of the greatest importance. Nothing will compensate for the want of this: but in addition, fresh air and exercise, and the avoidance of everything which interferes with health and therefore with digestion, are indispensable. The same observations apply to the treatment of nervous headaches. Whatever tends to keep the general health at the highest possible point, will, in the same proportion, diminish the headache. Coldness of the feet should always be guarded against. A nervous headache is sometimes removed by keeping the feet for some minutes in water as warm as can possibly be borne. In other cases a good cup of tea is very useful. Tea, however, being a nerve stimulant, the repeated

use of which is followed by nervous depression, should not be used too freely, because it tends to perpetuate the very disorder which it is employed to relieve. Twenty drops of sal volatile in a little water are not injurious, and are frequently very efficacious. In cases of headache from immediate exhaustion or fatigue, nutritious food and wine are the best remedies. Some of the headaches caused by too much blood in the brain are those which more particularly concern the medical practitioner. As for such as are due to over mental exertion, the remedy is in every one's own power. Let it be remembered that while the brain tires just as do the arms and legs, over-exercise of the brain, for reasons previously given, is much more injurious than over-exercise of the muscles.

For rheumatic headache the best domestic remedy is warmth, and this the patient instinctively seeks. This, when the pain is severe, may be advantageously supplemented by a mustard poultice applied as near the affected part as the hair will permit.

IV.

SLEEP.

Sleep is as necessary to existence as food, and yet sleep is in fact a partial suspension of some of the functions of life itself. All these functions are performed with intermissions. Rest is in some way or other provided in every instance. Respiration and the circulation of the blood never cease for a single minute from birth until they are still in death. Notwithstanding this, the heart reposes during about one-fourth of life, and the lungs are inactive during about one-third of the same time. In the case of the heart, this is effected by an interval of rest which occurs between each combined act of contraction and expanpansion, and the beginning of a fresh act; and in that of the lungs, by a period of repose between each expiration and the succeeding inspiration. The stomach, the liver, and the various other glands have also their times of rest.

"Blessings on him," says Sancho Panza, "who invented sleep." This is a sentiment in which all the world will agree. Sleep is, indeed, as much the true

remedy for the troubles and worries of the mind, as it is for the fatigues of the body. In every one's life there are occasions when the gloom of the present is only exceeded by the darkness of the future. If there were no such thing as sleep, a man would succumb either mentally or bodily; he would die of exhausted nervous power, or if it were possible for him to live, would become a maniac.

After some hours of the deepest mental distress, relief is usually brought by sleep, and the sufferer feels his exhausted powers revive. He wakes with the memory of his troubles still present to his mind, but also feeling that he is better prepared to face them. The keenness by which they wound him is somewhat blunted; and this gradual process of blunting is nightly repeated. Thus, by causing intermission in our troubles, it is that "tired nature's sweet restorer" reanimates our drooping spirit.

The immediate cause of sleep—that is, the mechanism in the body by which it is produced—was until recently quite misunderstood. It was formerly supposed that pressure on the brain afforded the explanation. Most writers on the subject have adopted this view, and some of the facts by which it is supported are very striking. Apoplexy is caused either by unnatural fulness of the vessels in the brain, or by the

rupture of a vessel which allows the escape of blood, and in either case pressure on the organ is established by one of them. This affection is attended by drowsiness, or by complete unconsciousness, according to the degree of pressure thus exerted. From this fact it has been inferred that sleep is caused by accumulation of blood in the head; and in support of this view certain other facts have been advanced, such as, that full-blooded people are usually the best sleepers, and that the recumbent position which promotes the flow of blood to the brain, induces sleep.

In accordance with these views, an ingenious theory was proposed to account for sleep. The brain is formed double; that is to say, of two equal portions or hemispheres, each having the same shape, one of which is placed at each side of the skull. Imbedded in each of these hemispheres, there is a cavity called a ventricle, and in each ventricle lies a peculiar agglomeration of flaccid-looking blood-vessels, as seen in the dead body, called the choroid plexus. Now it was supposed that when sleep took place, these vessels became so greatly distended with blood as to fill up and make pressure upon the sides of the cavities, and that this pressure continued so long as sleep continued. Many instances have occurred in which a portion of the brain has been laid bare by acci-

dent, or as a curative measure. In a case of this sort it is always found that consciousness can be instantly suppressed by pressure upon the brain. This was supposed to give strong confirmation to the pressure theory of sleep. But there is a wide difference between stupor and sleep; the one is a result of diseased action, and it is difficult or impossible to rouse the person from it, while the other is a natural state, from which he is easily aroused.

It has now been determined, that so far from containing more blood than usual, the brain during sleep contains much less blood. We are told on very high authority, that "the blood is the life" of the body, and the tendency of modern physiology is to regard the blood as the origin of all force, and of all the functions in the system. Now when the circulation in the brain is diminished, it becomes deprived of the proper stimulus by which its state of activity is maintained; its vitality, in fact, becomes lowered, and it sinks into a state of quiescence. It then obtains rest, which during our waking hours it never has for a single instant. And it is doubtless during sleep that the waste the brain has previously undergone is repaired, and that the injuries inflicted upon it by over-exertion are made good. For it must be borne in mind that every act of life, whether it be

the motion of the hand which guides the pen in writing this sentence, or the action in the brain, which conceives it, is accompanied by waste.

The proofs that sleep depends on a comparatively bloodless state of the brain, have been chiefly derived from experiments on the lower animals. And here we must at once meet an objection that has been raised on the score of cruelty, and that such proceedings are unjustifiable. First, it must be remembered that the operative portions of all experiments of the kind are conducted while the animals are under the influence of chloroform, by the benign effects of which all pain is annihilated. Secondly, while we regard with abhorrence the unnecessary mutilation of any creature, we are as decidedly of opinion that it is proper and justifiable under certain circumstances. The close analogy in structure which exists between man and the lower animals, has, by means of experiments on the latter, led to a greatly extended knowledge of the human functions. There has been so much lately of what we regard as a mistaken advocacy of the rights of the lower animals in this matter, that we have been tempted to digress thus much in order to state plainly our own convictions before the experiments to be now mentioned are brought before the reader.

Portions of the skull have been removed from living dogs, by experimentalists in this country, in France, and in America. By this means the brain has been laid open to accurate observation. It has been determined that when the dog sleeps the exposed brain collapses, that it sinks within the skull; when, on the other hand, the animal is awake, and especially if excited, the exposed brain swells out, and sometimes even protrudes beyond the aperture in the skull.

These observations are supported by what may be easily verified, but in a less evident degree, in the human subject. There exists in the infant, for a considerable time after birth, at the top of the head, where the angles of the separate portions of which the skull is composed do not meet, a small space as yet unclosed by bone, and only covered by the proper membranes of the brain and the outside skin. When the infant is pleasurably excited, or when it screams from passion or from pain, this part may be observed to swell out, and when asleep it will be seen to sink below the level which it assumes in the tranquil state while he is awake.

From these and other considerations, it is now the most generally received opinion, that sleep is caused by a withdrawal of blood from the brain.

It is certain that sleep, or at least an intermittent cessation of functional activity, is a necessity of life throughout nature. Every one is familiar with the mode in which many plants close their flowers at the approach of night; and some, as the trefoil, sleep with their leaflets folded together. But besides such peculiar instances, there is a great difference between the functions performed by all plants during the day and during the night. As for animals, no doubt the oyster has his doze, and there can be as little doubt that the warm-blooded whale not only sleeps but dreams. There is an analogy between the winter sleep of animals and that of most kinds of plants which also hybernate, as shown by their leafless and deathlike state.

In perfect sleep there is no consciousness. It has been therefore called with truth the image of death. It is a temporary death, as far as concerns all action and motion which lie under the power of the will. But although the brain is at rest, the heart and lungs continue their tasks, because they are presided over by a department of the nervous system which acts independently of the brain. The brain is the seat of consciousness, and from it all the nerves which originate and control voluntary motions take their rise more or less directly.

Dreams generally occur when sleep is unsound, and the phenomena give much support to the theory of Gall, that the brain consists of separate organs. When, says he, "one organ is active, the dream is simple: the object of our love is embraced, harmonious music is heard, we fight our enemies, according as one organ or another is performing its functions." Dreams are supposed by many to be excited chiefly by the memory of something which has occurred a short time previous to falling asleep. But this is the exception rather than the rule. They consist more frequently of the revived recollections of old events, and often of those which seem to have been quite forgotten. One of the most remarkable things connected with dreaming is the absence of judgment. We converse with the dead, and even though we may know them to be dead, this excites no surprise. Fear also is generally absent. Another curious circumstance is that space and time have no existence in dreams. It has happened to most people to dream that they passed through some long period of days or even of years, while they have been only a short time asleep. But still more curious is the fact that some sudden impression on the senses—such as the noise of shutting a door, or the entrance of light into the room where a person is asleep, and by

which he is awakened—is often the exciting cause of an elaborate dream, in which the noise or the light is the point upon which all the incidents turn. There seem, indeed, to be many things connected with our mental structure which are, as it were, analysed and dissected for us by the process of dreaming, could we but interpret them rightly.

A book might be filled with the account of the so-called prophetic dreams which have been published. Many otherwise strong-minded persons have been so struck by a dream of this kind as to give credence to the connection between it and the event which it appeared to foreshadow. But it has always seemed to us that in such cases one consideration has been entirely overlooked; it is this: People are constantly experiencing remarkable coincidences, such as the unexpected meeting with persons of whom they had been at the time talking or thinking; or the coincidence may be of such a nature as to make it important or valuable in connection with something about to be done or not to be done. But it never occurs to them that in such a matter anything supernatural has supervened. Now, since coincidences are by no means rare in the waking world, why should they be regarded as rare in connection with the world of dreams? Why, in other words, should it be

thought necessary in the one case to attribute that to the supernatural, which is accepted as in accordance with the doctrine of chances in the other case? Let it only be considered what thousands of dreams are nightly experienced, and that out of these thousands a considerable number have sufficient point to be remembered afterwards. Is it, then, surprising, considering what occurs in every-day life, if in a few instances our dreams seem to be fulfilled? This without question is the true explanation of so-called prophetic dreams.

Dreaming is not peculiar to man. Horses neigh in their sleep, and every one is familiar with the angry growls, as well as the cheerful bark, which proceed from the sleeping dog. There can be no doubt that the memory of incidents in dog-life, such as of the combat or of the chase, are in such cases present to the animal's consciousness. Children dream almost from birth, and they suffer more from frightful dreams than adults do. The dreams of childhood not unfrequently make impressions upon the mind which endure throughout life. It has been supposed that our dreams become less extravagant and inconsistent as we grow older. This seems true on the whole; but at times the most extraordinary dreams occur at every period of

life. Old people seem to dream more than the middle-aged; but, unlike the young, the aged seldom speak in their sleep.

Nothing has a greater influence in producing dreams than indigestion. A late meat supper, taken when the want of it is not felt, is almost sure to disturb rest and cause uneasy dreams. It is recorded of the authoress of the "Mysteries of Udolpho," that she was in the habit of supping on the most indigestible things possible, for the purpose of conjuring up horrors, to be afterwards transferred to her pages. Dryden on the other hand, is said to have eaten raw flesh with the view of obtaining splendid visions. As already stated, external circumstances have much power in modifying or inducing dreams. Instances are recorded in which any kind of dream could be procured in the sleepers by whispering in their ears. An officer, who was the subject of practical jokes of this kind, has thus been made to go through the different stages of a duel, and at last to fire a pistol when placed in his hand, by the report of which he was wakened. On another occasion the same person was in this way led to believe that he had fallen into the sea, when he immediately moved his limbs as if to save himself by swimming. He was then exhorted to dive, in order to escape from a shark, and in attempting to do so received a severe injury

by throwing himself from the bench on which he lay. At another time, when living in camp, he was made to believe that he was engaged with the enemy, and that the man nearest to him had fallen. Upon this our sleeper exhibited such marks of fear that he rushed from his bed, and was only roused by falling over the tent ropes. This gentleman, probably from motives of convenience, was in the habit of stating that he never preserved any distinct recollections of his dreams.

Many people answer questions put to them during sleep, and some awkward disclosures are said to have been in this way obtained.

Not only was it an ancient belief, but some amongst the moderns, such as Baxter, supposed that dreams were caused by the suggestions of demons or spirits which haunt our atmosphere. They imagined that these incorporeal beings possessed the power of thus tormenting, of amusing, or even forewarning us in our sleep, according as their intentions towards us were bad or benevolent. But there is no necessity for any such supposition. We know that in the waking state thoughts spring up in the mind without any suggestion from our senses, and apparently in a spontaneous manner. When, therefore, the brain becomes excited in sleep, by the aid of memory, images are formed which, since judgment remains in abeyance, take form and

action. We have seen, too, that in some cases dreams may be produced by exciting bodily sensations, and, in fact, a large class belong to this order. There is a great tendency to exaggeration in dreaming. If the bedclothes fall off and the sleeper becomes chilled, he is apt to dream that he is in some way subjected to the influence of extreme cold. If, on the contrary, he is oppressed by too much covering, he may dream he is sweltering under the rays of a tropical sun. The smoke of a chimney filling the room may suggest the conflagration of a city; the sound of a flute, an harmonious concert; while that of a trumpet may excite a vivid representation of the last day, the dead rising from their graves, and marshalled by angels preparatory to that most awful of all scenes, the Final Judgment.

It is not, then, to be wondered at if the intellectual faculties sometimes continue active during sleep, and that the results have been found equal to the mental power of the dreamer. La Fontaine made admirable verses in his sleep. Alexander is said to have planned battles. In the same way mathematicians have solved problems, and schoolboys have accomplished tasks. This leads to the consideration of sleep-walking, or somnambulism. For in some instances, not only have mental feats been performed during sleep, as the composition of poetry or the solution of a problem, after-

wards preserved by the waking memory, but the sleeper has risen from his bed and deliberately written down his poem or his problem. In this condition not only are the memory and intellectual powers in an active state, but the powers of volition are also more or less active. In addition to this, one or more of the senses is aroused, while the others remain dormant. If the sense of sight be alone thus stimulated, the dreamer may see objects perfectly, and yet be completely insensible to sound; or he may see and hear, and be quite insensible to touch. In the meantime, power, as regards the exercise of his muscles, may be complete. Thus he may write down his thoughts, or he may do his mechanical work, and then return to bed and to complete unconsciousness. But as in such cases judgment is also in abeyance, his actions may be not only erratic, but fraught with danger to himself or to others. He walks safely on the edge of a precipice, or on the roofs of houses, only because he has no fear. He sometimes avoids danger, and this has been attributed to a kind of instinct rather than to reason. But to us the influence of habit seems enough to account for all. He will not willingly place his foot where there is absolutely no foothold, because he has always been accustomed to this precaution.

Very numerous authentic instances of this affection

are recorded; and it may be well here to draw attention to the difference between the kind of testimony by which such facts have been established and that upon which the occurrence of supernatural dreams rests. The evidence in case of sleep-walking is objective—the fact is obvious to others, and is generally established by many witnesses; but in the case of supernatural dreams, or of apparitions, the evidence is generally altogether subjective, and dependent upon the statement of the individual who is the subject of the phenomena. It has been already pointed out that coincidence must be taken largely into account, in any attempt to explain so-called prophetic dreams. But in case of what may be called the higher manifestations, in which some extraordinary revelation is said to have been verified, or some startling vision has been seen, it is a suspicious circumstance that the accounts are seldom those which come direct from the person who has experienced them. Men easily magnify what they fear, and such narratives never lose by oral transmission.

But to return to sleep-walking. In 1686, a brother of Lord Culpepper's was tried at the Old Bailey for shooting one of the Guards. He pleaded somnambulism, and nearly fifty witnesses were called to prove the extraordinary things he did in his sleep. Upon this

evidence he was acquitted. A lad at Fribourg, who had been a somnambulist from his infancy, was in the habit of reading in his sleep; he would also, at the request of his tutor, find out places on the maps, which he did more readily than when awake. His eyes were at such times always open and fixed. In America, there was the case of a farmer who would rise in his sleep and thresh out several bushels of corn in the dark, and also carefully separate the grain from the straw. A drover was known in the same way to have killed and quartered a sheep. Dr. Haycock, of Oxford, delivered sermons in his sleep; nor could he be prevented even by rough usage. Such a list might easily be increased; but a few instances are given to show what has been accomplished by sleep-walkers.

As might be expected, it is unsafe to try to waken a somnambulist when discovered in a position of danger —such as on a window-ledge or on the roof of a house. If, as would most probably occur, he did not fall when in the act of wakening up, he would still run the greatest risk from an unsteadiness which he had not experienced while asleep. Cases are also recorded in which the mere act of rousing the person has been attended by fatal effects. It is not surprising that a person even of strong neves should be violently agitated by finding himself in a position at the moment altogether inex-

plicable. In a case of weak nerves, a shock might be terrific. An instance is related of a lady who was so persistent a sleep-walker, that her friends were in the habit of securing the windows and door of her chamber, to prevent her escape during the night. On one occasion these precautions were neglected, and she was discovered in the adjoining garden. She was there awakened by her friends, but such was the shock which her nervous system received, that she expired almost instantly.

The affection called nightmare is in certain respects distinct from ordinary dreaming. While the imagination and the memory possess full fling, the power of the will is either absent or greatly impaired. In addition to this, the function of respiration is much impeded; and out of this, in some shape or other, a horrible association of ideas usually springs. Nightmare, in fact, furnishes some of the most distressing sensations that can be experienced. All the store of horrors which the mind has accumulated or conceived seem to come up at its call. From these, whatever is most disgusting or appalling seems to be selected, and to be moulded into shape. The sufferer is tortured by demons; he is gored by bulls; entwined by serpents; sat upon by some slimy monster; or drawn by a fiend to the very edge of a precipice, on which he hangs only by every effort of his strength. There is often

a feeling that such suffering is inflicted through malice, and that some malign influence is at work against him, to which all resistance is vain. A sense of oppression and want of free action are indeed characteristics of the affection. If the person thinks he ought to run, he finds that he can hardly move his legs. If he tries to escape through some door or aperture, he finds it too narrow. He fancies himself buried alive, and is unable to turn in his coffin or to make any noise that would bring help. If he struggles with some monster, it is only to exhaust himself to no purpose; his toil is only rewarded by the mocking laugh or the demoniacal stare of his tormentor.

Such is an imperfect attempt to describe the sensations caused by nightmare; but most readers will be able to complete the picture for themselves, in a manner more forcible than can be expressed in words. Sometimes we pass from a state of perfect sleep into that of nightmare; at other times it comes on when we are between sleeping and waking, or when just dropping off to sleep. Generally speaking, the sufferer is roused by the violence of the attack, and it seems to be thrown off by a great effort of voluntary motion. He is then apt to rise up in bed, and sometimes cries aloud for help. As soon, however, as the capacity for action is brought under the power of the will, the

attack is at an end. The heart now beats violently, and a cold shivering sometimes comes on.

Nightmare generally happens to us when lying on the back, but this is not invariable; and it is often difficult to say whether or not the person has not turned on his back during the struggle which precedes recovery. What we have said of delusions about the lapse of time in reference to dreaming, applies also to nightmare. It is, therefore, impossible to determine how long an attack may have lasted. A minute of such misery may well appear an hour.

Indigestion is unquestionably the chief cause of nightmare. Any one whose digestion is not the strongest, may almost infallibly bring it on by taking without appetite a late heavy supper. An excellent receipt for it would be a veal pie, in which solid indigestible meat is combined with pastry. The disorder also plagues people who are asthmatic.

Various explanations have been offered of the immediate cause of nightmare; but impeded respiration is at all events essentially concerned. This may be induced by flatulence, which causes the distended stomach to press against the diaphragm, and so interferes with the free motion of the lungs. But an undigested meal lying in the stomach may in another way cause disturbance in the chest. The stomach irritation is then transmitted to

the lungs by means of their intimate nervous connection. The cure of nightmare, unconnected with organic disease, consists in avoiding suppers, attention to diet in general, as well as in a sufficiency of fresh air and healthful exercise.

The approach of sleep is known by a sense of weariness and muscular fatigue. Attention to what is passing before the senses flags, and conversation fails to excite it. All external impressions grow dull, the memory becomes confused, and questions are replied to incoherently. If we struggle against the invader and try to read, the lines seem to run into one another. The head droops at intervals from momentary unconsciousness, the upper eyelids close in spite of every effort to prevent them. If sleep is now encouraged, a brief and not unpleasant state of semi-consciousness steals on, which soon passes into complete oblivion.

Waking probably depends on the return of blood to the brain in obedience to the stimulus given by one or more of the senses, as light, noise, or touch. Habit, too, has a strong effect; and there is no doubt that all these influences are controlled and directed by the sympathetic nervous system, by whose ever-watchful agency the functions of life are kept in action both during sleep and when awake.

The proper duration of sleep cannot be absolutely

fixed; some men require much more than others; and age, the amount of work performed during the day, whether physical or intellectual, and other circumstances, regulate the demand. Infants sleep the greater part of their time. Children require more than adults, and, as a rule, the middle-aged more than the old. It is no uncommon thing to see old men pointed out as models of early rising to their younger friends. This is a mistake, for in truth the old get up early because they are unable to rest in bed. But there are exceptions to this. Old Parr slumbered away much of his later life; and De Moivre, when past eighty years of age, slept twenty out of the twenty-four hours. It has also been observed that in the dotage of old age, as if to complete the parallel between the first and second childhood, sleep again predominates. Sleep in the aged is very apt to occur after meals.

As a rule it would seem that the larger the brain of any animal is in proportion to its body, the more sleep it requires. Birds, which have small brains, sleep little; dogs, whose brains are much larger, sleep a great deal. But monkeys sleep little, although their brains are not small.

Perhaps no better division of time can be made than that of Alfred the Great. He assigned eight out of the twenty-four hours to work, eight to amusement, and

eight to sleep. The demands of modern life in most instances sadly disturb such a relation between work and play; but the period he assigned for sleep seems to accord with general experience. Less than eight hours' sleep is insufficient for most men and women when in health, and more is unnecessary or even injurious. In this matter, too, there are exceptions. Jeremy Taylor trained himself to exist on three hours' sleep out of the twenty-four. Frederick the Great and John Hunter slept only four or five hours in the same time. Wesley lays down the proper duration of sleep at six hours, and Lord Coke at seven.

Many instances in which sleep has been greatly prolonged beyond the average duration are also on record. Boerhaave mentions the case of a physician who conceived the idea that sleep was the natural state of man, and he slept eighteen hours out of the twenty-four. But he soon slept himself out of the world, as he died of apoplexy induced by his indolence. Elizabeth Perkins fell into a deep sleep, from which nothing could rouse her, and remained in that state between eleven and twelve days. A man who lived near Bath is said to have at one time slept for a month. There is little doubt that in many of these cases the brain was diseased. Narcotics sometimes cause sleep to be much more protracted than was expected. Notwithstanding numerous

exceptions, it seems that average people require to spend about one-third of life in sleep.

The hour of going to bed must of course depend on the habits of the individual. Persons who get up early must go to bed early, and *vice versâ*. Much has been written in praise of early rising, and with some truth. There is an undoubted relation between sleep and night, when, with few exceptions, all animated nature reposes. It is also a good, though not an indispensable, rule of health to retire to rest early; the real point being to obtain sooner or later the requisite eight hours' sleep.

No greater domestic improvement has been effected than the substitution of hair mattresses for feather-beds. Perspiration is more active during sleep than when we are awake, and it is unduly encouraged by the sinking of the body in a soft bed, which also enervates the entire system.

The open state of the pores of the skin makes sleeping in the open air hazardous. But the belief that the moon-beams exercise a peculiarly noxious influence on a sleeper who is exposed to them is unfounded. Most people sleep best on the right side; the chief reason of this is that the heart lies towards the left side. When, therefore, a person lies on the right side, greater freedom is given to its motions. In many countries it is the habit to sleep on hard boards, and the ancient Egyptians slept

with the head supported on an iron bar bent to its shape. This one thing only seems to belong to all times and to all countries, that when possible people always sleep lying down. But in cases of great fatigue, neither this, nor even a state of rest, is indispensable. People have often slept while riding on horseback. In the retreat of Sir John Moore during the Peninsular War, many of the soldiers were found to be fast asleep while they were marching. It is indeed astonishing how well sleep can be indulged in under difficulties. Men worn out by fatigue and loss of rest at the siege of Sebastopol, slept soundly in the batteries during a bombardment. Coy and fugitive when sought after, sleep unsought is often an irresistible influence.

A high temperature strongly induces sleep. In some warm climates the siesta, or midday sleep, is an established usage. Sleep from heat is preceded by great lassitude and indisposition to exertion of either body or mind. If a person gives way to it, he drops into slumber quite suddenly, but it is not attended by the refreshing effects of ordinary sleep. He is apt to awake feverish and thirsty, and with a dulness and confusion of thought which last for some time.

A moderate degree of cold prevents sleep, while excessive cold has not unfrequently been the cause of apparent sleep ending in death. In some cases the

drowsy tendency from cold is so irresistible, that it is indulged in with the full consequences before the mind. Travellers in the Rocky Mountains are sometimes overtaken by storms far from shelter, and exposed to a very low temperature while crossing this bleak and elevated range. In such a situation to sleep is to die. A remarkable instance of this kind is related in Captain Cook's Voyages.

Mr. Banks and Dr. Solander had ascended a mountain in the island of Terra del Fuego. Here they became exposed to an extremely low temperature, and Dr. Solander, knowing the risk of delay, did all in his power to keep the party in motion. "Whoever sits down," said he, "will sleep, and whoever sleeps, will wake no more." Notwithstanding this, the Doctor was himself the first to give way to the temptation, against which he had so forcibly warned his companions. He threw himself down upon the snow with which the ground was covered, and it was with the greatest difficulty that Mr. Banks could keep his friend from sleeping. One of the black servants now began to give way. Others of the party were then sent forward to have a fire lighted at the first convenient place, while Mr. Banks remained behind with Dr. Solander and the servant. Partly by persuasion and partly by force, they were got through the greater part of a swamp difficult to pass, when both

declared that they would not proceed. The black man was now told that he would be frozen to death, and he replied that he wished only to be allowed to lie down and die. Dr. Solander said he was willing to go on, but that he must first sleep. As their companions were unable to carry them, they were now permitted to sit down, and both sank almost immediately into a profound sleep. Soon afterwards the news was brought that the fire had been lighted about a quarter of a mile farther on. They were now so fortunate as to awake Dr. Solander. But notwithstanding that he had not slept more than five minutes, his limbs were almost powerless, and his feet had so shrunk that the shoes fell from his feet. He completed the short journey to the fire with great difficulty, and only by the assistance of his party. But their efforts to save the black servant were unsuccessful.

It may strike the reader as strange that such opposite conditions as great heat and great cold should equally be the cause of sleep, while a moderate degree of cold keeps a person awake. As for the last, it seems to act simply as an uneasy sensation would do in preventing sleep. Extreme cold causes the blood to accumulate in the internal organs, including the brain, because it is driven from the surface by contraction of the superficial blood-vessels. The result of this is stupor, and not sleep,

which we have called it only for convenience, and because it has been generally regarded as true sleep. The effect of great heat, on the contrary, is to increase the amount of blood circulating in the superficial parts and in the extremities of the body. This causes a lessened flow of blood through the brain, followed by sleep.

Such is a sketch of one of the most remarkable phenomena of our being. Although modern research has divested sleep of much of its mystery, there is still much to be learned; but, judging from what has been already achieved, we may expect with confidence still greater results.

V.

SLEEPLESSNESS.

In the preceding chapter, we gave an account of the phenomena of sleep, deduced from the labours of many observers.

So far as has been ascertained, a lessened flow of blood through the brain is the cause of that total obliteration of consciousness and of all voluntary motion known to us as perfect sleep. It is necessary to bear this in mind, in order to comprehend what we have now to say about sleeplessness.

When the brain is most in action, it attracts to itself most blood. Every one who has spent many consecutive hours in literary composition, or in abstruse calculation, will be able to recall the sensation of fulness and of throbbing in the head, and, if the work be still persisted in, the headache which such close application sometimes induces. From these considerations it is not difficult to form a theory of the cause of wakefulness, which facts as well as analogy show to be true. Provided that circumstances are favourable, sleep comes on when that power of the brain through which the

mind and the senses act requires to be renovated. It is usually requisite that the body be placed in an easy position, and that access of light and of sound be prevented. As we have previously pointed out, the power of the brain to sustain itself in action may be exhausted more rapidly than ordinary by fatigue, by heat, and by other causes. Habit also, by which all the functions of the body are greatly influenced, has much to do with sleep.

The simplest form of wakefulness, then, is that which occurs from a violation of one or more of the conditions appropriate to sleep. Thus a bright light in the room, an unaccustomed noise, or an uncomfortable bed, suffice to keep most persons awake. An excess in the very causes which induce sleep also commonly prevents it. Over-fatigue is usually followed by vigilance, and such is the effect of habit, that some persons are unable to sleep if they remain long out of bed beyond their usual time of retiring to rest; or, on the other hand, if they go to bed unusually early.

When the brain has been once stimulated to activity, it requires some time before the circulation of blood through it regains the balance which is maintained in the waking state. When this balance is regained, most persons easily fall asleep if other circumstances are favourable. Many people indeed possess the

faculty of sleeping at will, by merely closing the eyes and otherwise shutting out external impressions. A great many persons, on the other hand, and particularly those of nervous temperament, sleep with difficulty, and some may be said to obtain repose only by stratagem.

Any intellectual effort immediately before retiring to rest is sure to be followed in such persons by a restless night. If, for example, a game of chess has been played, the various moves and positions on the board are long vividly present before the mind. This kind of misfortune is only to be averted by avoiding the causes which induce it. If, on the contrary, the circulation in the brain is habitually kept at an unnatural tension, the difficulty with which it returns to the state necessary for sleep is nightly increased.

Many articles cause wakefulness when taken internally. Of these, tea and coffee are the most familiar. Every one knows that either, but especially tea, when taken too strong, prevents sleep. Opium, belladonna, or Indian hemp, in small doses, produce the same effect. There are good reasons for believing that all these drugs act alike, in at least one respect, namely, by increasing the circulation of blood in the brain. This is attended by increased activity and power of thought. Each of these substances has also a specific

action of its own. There is a difference between the stimulation caused by tea and that from coffee. The pleasurable sensations and the reverie caused by opium are peculiar to the drug. Indian hemp or *hashish*, which is its Eastern name, if taken beyond a certain extent produces a succession of mental images and pleasing hallucinations, the nature of which would of itself require a long chapter to describe. It is remarkable, too, that although all these articles may produce wakefulness, this in some cases depends on the dose in which the particular drug is taken. Opium in sufficiently large doses produces sleep, but tea taken in large quantity is not accompanied by this effect.

Nothing banishes sleep more effectually than pain. Patients suffering from neuralgia have been almost sleepless for months. But no amount of pain can altogether do away with sleep, nor will mental depression or fear prevent repose when exhaustion ensues. Wretches are said to have slept while undergoing the punishment of the rack, and culprits usually sleep soundly on the night preceding their execution.

Cold, when not excessive, dispels sleep, because of the discomfort it induces, and probably also on account of the derangement of circulation which it produces. Coldness of the feet is a very common source

of wakefulness. A sensation of dry burning heat in the soles of the feet and palms of the hands, to which some people are liable, and which also accompanies certain diseases, is another cause of sleeplessness. Sponging the parts with vinegar and water relieves this affection.

All mental emotions are unfavourable to repose. The merchant who has been fortunate in some daring speculation cannot sleep if he dwells upon his successes after retiring to rest. Another who has met with reverses will be sleepless from sorrow if, as too often happens, his losses intrude upon his thoughts during the night. But it must be admitted that, as a sleep-dispeller, joy is far inferior to grief. The memory of what we achieve or of what we gain is never so persistently active as the memory of what we lose. The recollection of the one soon dims through repetition, while that of the other long preserves its force.

Another great enemy to repose is an over-active imagination. A man whose thoughts run riot, so that with closed eyes he mentally sees pictures pass in rapid succession, like a vast panorama, will never sleep as long as this state of things continues. One great essential for sleep, as we shall afterwards see, is simplicity of mental action.

Indigestion is a very common cause of wakefulness. Anything which acts as an irritant to the stomach is apt to irritate the brain by means of the close union which exists between these organs through the medium of nerves.

On the other hand, that kind of exhaustion which occurs from want of food frequently prevents sleep. When a person accustomed to dine late happens to dine early, and goes to bed without any substantial refreshment, he is very liable to find himself utterly sleepless. It may be that no actual hunger is experienced. It is rather an indefinable sensation of sinking in the region of the stomach which gives no distinct indication of the want of food. This kind of sleeplessness is apt to be very persistent, because the exhaustion increases in proportion to the time during which the person remains awake. In such a condition a sandwich and a glass of wine or pale ale act better and more speedily than an opiate. No sooner has food been taken, than a glow of comfort and a tendency to repose succeed, and the person soon falls into refreshing sleep. It is not difficult to comprehend how this occurs: the brain in its previously vigilant state was too full of blood, by which its unnatural activity was sustained. When food is taken into the stomach the process of digestion is excited, and the

superabundant blood is, by this means, diverted from the head to the abdominal organs.

Another cause of sleeplessness, little recognised, is taking stimulating drinks. It is certain that in a great number of instances stimulants do not agree with the system, and that many people would sleep much better if they abstained from them altogether. Those who indulge freely at night are apt to awake very early in the morning and remain long sleepless. This is by no means inconsistent with the fact that a certain dose of brandy and water, or its equivalent, is considered by some persons indispensable to repose. Anything to which the system has become habituated from constant repetition grows into a necessity. In the present case an unnatural want is established, which, if not attended to, is a cause of discomfort and consequent loss of sleep.

The effects of protracted wakefulness sooner or later show themselves in the strongest constitution. The person becomes gloomy, irritable, and peevish. The memory is defective, and the thoughts confused. Perhaps the most terrible punishment which Chinese ingenuity has devised, is prolonged loss of rest. In some instances it leads the way to, and even seems to be the cause of, insanity. Some of the greatest intellects have suffered from privation of sleep:

Newton's mind was impaired by it in his later years; Southey's insanity was preceded by it. The more gifted and cultivated the mind of an individual is, the more liable he will be to wakefulness. The untutored sons of bodily toil have but few vigils, and amongst all the animals sleeplessness without external cause probably belongs to man alone. The lower animals are soon affected by loss of sleep. In Ceylon, wild elephants are kept constantly awake until they become tame; by this means the spirit of the most refractory is soon subdued.

In order to promote sleep in cases where it is wanting, it is of course in the first place necessary to remove every exciting cause of wakefulness. It is generally essential to give up the use of tea and coffee, and, as has been said, it is sometimes necessary to leave off stimulants. The person should take care that he does not go to bed either with cold feet, or with a stomach that has been either long empty or scarcely filled.

Many devices for inducing somnolence have been practised with more or less success; one of these is combing the hair, which has a very soothing effect on some persons. Another is to have the feet gently shampooed. Walking about the bed-room in one's night-dress, so as to get what Dr. Franklin called an

air bath, is a good plan, and the cold-water bath just before retiring to rest, by virtue of its stimulating action, is often successful. In more refractory cases the warm bath may be tried—it acts by withdrawing the blood from the brain. On the same principle, the upright position, by favouring the return of blood from the head, is sometimes useful. It is, indeed, no uncommon thing to meet people who sleep with great facility when sitting in a chair or in a carriage, but who sleep with difficulty when lying down in bed.

The best bed to sleep upon is a hair mattress, and the worst of all is that made of feathers. Many people are so susceptible that they are unable to sleep in a strange bed. A pillow filled with hops, the emanations from which are narcotic, has been sometimes used with success to induce sleep.

People as a rule go to sleep most easily when lying on the right side. Proper ventilation of the bed-room is indispensable for sound sleep and for health.

Sufficient out-door exercise should in every instance be taken, and those who are strong enough should carry it to a sense of fatigue. In the Satires of Horace, to swim three times across the Tiber is recommended as a means of procuring deep repose.

In a state of health, when the balance between mind and body is properly maintained, sleep will naturally

follow either mental or bodily fatigue. This balance is often sadly disturbed because the besetting evil of our generation is over-stimulation of certain tendencies. Nothing is more important in order to secure sleep, than to diminish the intensity of thought. Under favourable circumstances this can generally be effected by the will. In other instances, however, the more the will is exercised against them, the more attention is given to the truant thoughts. At length the will, borne down by the torrent of ideas, gives way altogether, and protracted sleeplessness results. It is hardly necessary to repeat here that such an active state of brain implies that the circulation through it is active, and that it is the opposite of this condition which prevails in sleep.

One of the most effectual modes of counteracting this state of things is to force upon the attention some monotonous train of thought, and to tire the brain by its constant repetition. Reading a dull book sometimes answers. Repeating short verses over and over, or counting backwards, is often successful. Monotonous sounds act in this way. Boerhaave ordered for a sleepless patient that water should be so arranged as to drop constantly on a metal pan. The murmur of a flowing stream is for the same reason soporific.

The whole chance of success lies in compelling the

mind by a strong effort of the will to give up the train of ideas by which it has been occupied, and to take up the less interesting and more simple ideas or perceptions presented to it.

Many years ago a curious plan for procuring sleep by this means was announced as a great discovery by a Mr. Gardner. As this plan made some noise at the time, and was reported to have seldom or never failed, we shall give a full description of it. Testimonials of the efficacy of his method were published by Mr. Gardner from his Royal Highness the late Prince Albert, Sir F. Buxton, Bart., Sir W. Cockburn, Mr. Sheridan Knowles, and other men of eminence. It may be, then, that some readers may owe us a deep debt of gratitude for placing the priceless blessing of sleep within their reach upon such easy terms.

Let us suppose, then, a person to be in a particularly wakeful state, and that he has tossed and tumbled about into the small hours of the morning without any feeling of somnolence. If he should now desire deep repose, the following proceedings must be adopted.

He is to lie on his right side, with his head comfortably placed on the pillow, having the neck straight, so that respiration may be unimpeded. Let him then close his lips slightly, and take a rather full inspiration, breathing through the nostrils as much as

possible. This last, however, is not absolutely necessary, and some persons breathe habitually by the mouth. Having taken the full inspiration, the lungs are to be left to their own action, that is, expiration is not to be interfered with. Attention must now be fixed upon the respiration. The person must imagine that he sees the breath passing from his nostrils in a continuous stream, and at the instant that he brings his mind to conceive this apart from all other ideas, consciousness leaves him, and he falls asleep.

Sometimes it happens that the method does not at once succeed. It should then be persevered in. Let the person take in thirty or forty full inspirations, and proceed as before; but he must by no means attempt to count the respiratory acts, for if he does the mere counting will keep him awake. Even though he may not now succeed in procuring very sound sleep, he will at least fall into a state of pleasant repose.

Such is the account, somewhat abridged, of this much vaunted "art of procuring sound and refreshing sleep at will," given by Mr. Binns in his "Anatomy of Sleep." He, it seems, purchased the secret from Mr. Gardner, and hints at his generosity in having made it public *gratis*. It is founded on the principle that monotony, or the influence on the mind of a single

idea, as we have already shown, induces slumber. The inventor had for years suffered great agony, with consequent sleeplessness, from an injury to his spine. In this sad condition, opium and other sedatives were found rather to increase than to allay his sufferings. He was a contemplative man, and at length discovered the secret of "subduing sleeplessness and commanding repose by a simple effort of volition."

The plan is at all events safe, and easy of application; and any wakeful reader can test it for himself.

In many severe cases of sleeplessness, opium and other narcotics are of great use, not only by procuring forced repose, but by breaking through the habit of not sleeping, into which the system had fallen. The administration of such potent remedies, however, requires the skill and the supervision of a medical attendant.

VI.

VENTILATION.

It argues a serious defect in our present system of education, that it should be necessary to explain the reasons why ventilation is essential to health. Such an explanation would be altogether out of place if people in general possessed even an elementary knowledge of the laws of life; in other words, of the conditions upon which health and life itself can be preserved.

Every one knows that fishes cannot live out of water, while land animals, for whose existence air is necessary, speedily perish if immersed in water. But if the explanation of these simple facts be asked, we believe we are not wrong in saying that the majority of persons would be unable to reply. Let it be remembered, then, that both fish and men, when they change places with each other, as regards the element in which they live, die from the same cause. That cause is the want of oxygen, the universal and indispensable agent of animal life. The fish dies in air because its breathing organs, or gills, are only adapted for purifying its blood with the oxygen with which water is saturated. Boil the

water, and thus expel from it a great part of its oxygen, and, when cooled down to its ordinary temperature, place the fish in this water, and death speedily follows. A man, on the other hand, dies in water, because his lungs are adapted only for extracting oxygen contained in air.

The atmosphere which surrounds the earth, forming a gaseous envelope of the thickness of about forty miles, has a definite and very uniform composition. Every hundred parts of it consist of 21 volumes of oxygen and 79 volumes of nitrogen; or, if we estimate its composition by weight, of 23 parts of oxygen and 77 of nitrogen. Practically, we may say that a fifth part of the atmosphere consists of oxygen. It also contains about one part in 10,000 of carbonic acid; a gas which, except it be highly diluted, is destructive to animal life.

Oxygen is, as has been said, a necessity of life, and the pure gas will sustain life for a short time; but it is of too stimulating a nature to do this long. Nitrogen, on the other hand, cannot sustain life at all: it would be deadly from its negative qualities, because it cannot, like oxygen, effect indispensable changes in blood. It seems that the use of nitrogen in respiration is merely to dilute the oxygen, so as to render it capable of being respired.

Carbonic acid gas is about one-half heavier than common air, and owing to this circumstance it is possible to pour it as one would a liquid from one vessel into another. From the same cause it forms a layer at the bottom of wells or even in a more open situation, as in the case of the celebrated Grotto del Cano near Naples, where it emanates from the earth. Every now and then we hear of sad accidents occurring to miners and others who place themselves in situations where they inhale this gas. The result is stupor, followed by loss of consciousness, and unless help is speedily given, by death.

This is the subtle enemy we have constantly to deal with in our houses, and against which we should be constantly on our guard. It is given off by animals in considerable quantities in the process of respiration, especially when they are in a state of exertion. A man produces about one-third less carbonic acid when sleeping than when awake.

Some persons are much more susceptible of the effects of carbonic acid than others; but, as a general rule, whenever the proportion which exists naturally in the atmosphere is slightly exceeded, bad results begin to be felt. A sense of oppression, languor, headache, and other nervous symptoms are produced. Nor are the evil effects of rebreathed air merely transient. No

cause tends more to excite into action a latent tendency to pulmonary consumption, if it does not really produce the disease, than the air of unventilated bedrooms. Air containing one per cent. of carbonic acid is highly injurious, but even half that quantity cannot be long breathed with impunity. Respiration can be continued only with difficulty in an atmosphere containing five per cent. of the gas, while thirty per cent. speedily destroys life.

Besides carbonic acid, the atmosphere contains in much more minute quantities another still more deadly compound, carbonic oxide. This gas is chiefly produced in our houses from the imperfect combustion of carbon in fuel. Carbonic acid, on the other hand, is given off when the combustion is more complete. Warming by artificial heat is also another great source of this last gas. The method of heating apartments so that the escape of the gases produced by combustion has to be perfectly effected, is a most important study. The combustion of some kinds of fuel is accompanied by the evolution of so much carbonic acid, that if ventilation be very defective, immediately fatal consequences may ensue. Every one has heard of deaths ocurring from burning charcoal in unventilated rooms, tents, or cabins of ships.

Other gases more or less contaminate the atmosphere

of houses. Sulphuretted and carburetted hydrogen, etc., emanate from sewers, and are most injurious to health. It seems to be impossible, even with the most perfect system of sewage, altogether to prevent the escape of these gases.

Another reason for the necessity of ventilation is, that respired air is always charged with vapour; we see the vapour out of doors when in cold weather made visible by condensation. About six grains of water are given off by the lungs per minute. This in the form of vapour, mixed with rarefied air from the lungs, ascends, because the combination is lighter than common air. It shows that in all methods of ventilation means should be employed to remove the upper strata of air; for although carbonic acid is heavier than the atmosphere, it also is carried up with the respired air. This happens, not only because the breath is warm, but also because the proportion of oxygen, which is is heavier than nitrogen, is lessened by respiration.

Amongst the innumerable laws which go to make up the perfect code of Nature, there is one which is expressed in the mixture of gases with each other. By the law of the diffusion of gases, carbonic acid, which escapes into the atmosphere, although much heavier, soon becomes so diffused that the open air always preserves sufficient purity for the purposes of

respiration. But notwithstanding the great bulk of the atmosphere, it is plain that in the course of ages its relative proportion of carbonic acid would be increased by the perpetual respiration of the animal tubes. Here, however, again a beneficent provision is obvious.

It is the function of the plant to absorb carbonic acid and to give out oxygen. Thus, by means of the enormous mass of vegetation with which the land is clothed, the purity of the atmosphere is sustained.

That water is purified on precisely the same principles as air, a few words will suffice to show. It is not long since the true theory of keeping fish in an aquarium came to be understood. Many will remember that the primitive aquarium consisted simply of a vessel containing water, in which fish were placed. It was then always necessary to change the water very frequently, in order to keep the inmates alive. This was, of course, owing to the consumption by the fish of the oxygen contained in the water, and the production of carbonic acid. The modern aquarium, however, contains not fish only, but growing plants. The plants restore the balance which the fish tend to disturb, and thus such an aquarium never requires to have its water changed. All that becomes necessary is to make up at long intervals for the losses caused by evaporation. Since men as well as fish, then, depend for their existence

upon this selfsame oxygen, and the sea, with interminable beds and groves of its peculiar vegetation, may be regarded as an immense aquarium, so may the atmosphere be regarded as a deep ocean consisting of a different medium, at the bottom of which live men and other land animals.

What, then, must be the case with people who, neglecting one of the most essential laws of life, shut themselves up in tightly closed day-rooms, and in bedrooms of the same kind, in which, at least one-third of their lives is spent? They are plainly sapping the foundations of health. They do not die speedily, like fish in a bowl of water unchanged, because they are not equally confined in their rooms, and because, in spite of all their ignorant precautions, some fresh air gains access to them through crevices. But they languish and feel unrefreshed by sleep, they become consumptive and die early, and their offspring is sickly and without vigour. It may be thought that this is an overdrawn picture. Many facts might be adduced to prove that the picture is but too real. Let one suffice. Her Majesty's Foot Guards are men in the prime of life, and undeniably picked out of the general population for soundness of constitution. Notwithstanding this, it was some years ago ascertained that the mortality amongst these men was excessive. It was

proved that while the deaths amongst the general male population of the same ages amounted to only 9·2 per thousand, they reached 20·4 per thousand among these vigorous Guardsmen. The investigation to which these sad facts led, showed that the mortality amongst them was caused by consumption, and that this was to be attributed to the very imperfect ventilation of the barracks. For example, a sergeant stated that he could not endure the fœtid atmosphere of the crowded sleeping-rooms before the windows had been opened. No wonder that many of these poor fellows succumbed to noxious gases as surely as, although more slowly than, they would have done to the shot of an enemy. Measures were then taken to ventilate the sleeping apartments, and the mortality among the same troops is stated to be now positively less, instead of being so much greater, than that of the general male population of similar ages.

It would be easy to mention instances of the directly fatal consequences which have resulted from the inhalation of impure air. But having already given a sketch of the composition of the atmosphere, we must hasten to describe some of its properties upon which ventilation depends.

Air in common with other gases expands in volume almost uniformly as its temperature is increased.

1,000 cubic inches of air at 32° Fahr., when raised to 212° Fahr. is increased in bulk to 1,375 cubic inches. This amounts to an increase of three-eighths of the whole volume. Now, one of the laws which regulate the motions of the atmosphere is, that the heavier or less expanded portions of it rush to the lighter or more expanded parts, and this motion continues so long as the difference of density is maintained. Let it be supposed, then, that the hot air, from a fire, as it enters a chimney fifty feet in height is at a known temperature, and that the temperature of the external air is also ascertained, the velocity with which air will move through the shaft is capable of being exactly calculated. The motions of the atmosphere, then, are caused by local alterations in its density arising from changes in its degree of warmth. It is upon this simple principle that the science of ventilation depends. In this way also the lightest breezes, as well as those grand phenomena to which we give the name of tempests, and notably the trade winds, are produced.

The necessity for external ventilation has been foreseen for us by nature. Noxious vapours arising from the earth, the smoke of cities, and the gases produced by decomposition and combustion, are at once dissipated by the winds. How oppressive the atmosphere becomes in calm warm weather, and what a

relief it is to feel oneself fanned by a breeze after even a short continuance of such a calm!

We have already said enough to show that when we surround ourselves with an atmosphere confined within a small space, the necessity for ventilation becomes urgent. Pure air is as necessary to us as pure food, and on this subject an old writer says quaintly, "that as everything that is proper for recruiting the decay of the solid or fluid parts of our bodies deserves the name of food, the air ought to be looked upon as real food, and that which is most necessary for us." A future generation will doubtless look back upon us of the present day with pitying wonder. Notwithstanding the knowledge we possess, rooms for living in are constantly being erected in which no ventilation can be effected when the door is closed except through accidental chinks. It comes indeed to this, that such apartments are only inhabitable owing to the imperfection of their construction. Science has, however, not been idle in this matter of ventilation. What is most required at present, is a more widely diffused knowledge of the subject.

A man produces by respiration about ten cubic feet of carbonic acid in twenty-four hours. Suppose him to be confined in a room containing 1,000 cubic feet of air, which a space ten feet square and ten

feet high would afford, he would in twenty-four hours contaminate the atmosphere to the extent of one part of carbonic acid in 100 parts of air. A certain amount of carbonic acid given off by the skin would have to be added to this. But suppose twelve persons to occupy the same chamber, and a like effect would be produced in two hours. We have previously shown that such a proportion as that just mentioned cannot be breathed with impunity. Health is daily sacrificed through inattention to the kind of atmosphere inhaled. People spend long winter evenings crowded together in badly ventilated small rooms, or else they pass hours in larger spaces, such as churches, theatres, and other places of assembly, which in relation to the numbers present are equally crowded.

It will be obvious that to insure proper ventilation two things are necessary: first that the cubic space of air in an apartment shall bear a proper relation to the number of persons who inhabit it; and secondly, that the air shall be sufficiently renewed. It is calculated that the cubic space requisite for each person in a house should never be less than 600 feet; but in hospitals, where the air is contaminated with emanations resulting from disease, 1,000 cubic feet in each ward is the minimum that should ever be allotted to each patient. Another great source of the consump-

tion of oxygen is the burning of candles, lamps, and gas-lights. The burning of gas is especially unwholesome, not only on account of its consumption of oxygen being very large, but because of the other deleterious gases besides carbonic acid which are evolved.

In order to do away with the injurious results which must arise from the assembling of persons in artificially lighted rooms, it is necessary that about six cubic feet of fresh air per minute shall be supplied for each person. But this of course involves the condition that an equal quantity of vitiated air be allowed to escape. The art of ventilation consists indeed in effecting this double purpose, and much ingenuity has been expended on the subject.

The different means employed have been divided into two classes—forced ventilation, and ventilation by spontaneous action. The first method is necessary whenever a larger number of persons are congregated in an apartment than its relative amount of cubic space would warrant. Sometimes fresh air, previously heated or otherwise, is pumped in, or it is blown in by a bellows, or a current is set in motion by means of a revolving fan, an Archimedean screw or other contrivance, and in some instances provision is also made for drawing off the foul air by mechanical means. Steam power is often employed to work machinery of

this kind. The practical difficulties to be overcome in ventilating by these methods are considerable. No greater proof of this can be adduced than the case of the House of Parliament and the different methods of forced ventilation which have been tried for them at an enormous cost.

The scope of this article is, however, limited. What is intended is, to impress upon readers, not only the necessity for ventilation, but how ventilation is to be effected in ordinary houses, by ordinary means.

The commonest and by no means the worst form of ventilating a room is by opening the windows. But since the heated and impure air always ascends, windows should open at the top, and extend to near the ceiling. It is a great mistake, however, to suppose that opening windows upon one side only suffices to ventilate an apartment. It often happens in the still and sultry atmosphere of summer that the temperature inside a room is the same as that outside. In such a case no more change will take place in the air of a room having windows which only open at one side, than would occur in the contents of an open-mouthed bottle immersed in water. In order to change the air of an apartment, means of escape as well as of entrance must be provided. If the door be kept open, so much the better; and if not, the inevitable imper-

fections in its fitting allow some air to pass. But whatever may be said about the wastefulness or inconvenience of open fireplaces, they have at least one great recommendation. In houses where no provision is made for ventilation—and, as already said, such a provision is altogether exceptional—the chimney is in this respect of essential use. When a fire is burning, an artificial upward draught is created, which materially assists in purifying our rooms in winter; and in summer, when there is no fire, the chimney acts as an air-shaft. But the fireplace in summer is too often closed up as tightly as possible with a fire-board. This is done for the sake of appearance, and no doubt generally in ignorance that appearance is consulted at the expense of health. The principle that double orifices are necessary for ventilation, should never be lost sight of. One of these should be as near the floor, and the other as near the ceiling, as is convenient, and they should also be placed, if possible, at opposite sides of the apartment.

Ventilation is even of greater importance during the night than during the day. More time is passed in the same atmosphere during sleep, than in our waking hours. The system is also more susceptible of noxious influences when we are sleeping. On these accounts the ventilation of bedrooms should be carefully attend-

ed to. Unfortunately an absurd belief still prevails that night air is dangerous. This belief we have taken some pains to aid in dispelling, in the chapter on "Taking Cold." Here we shall only add, that no air admitted from without is likely to prove half so perilous as that which is breathed and re-breathed by the unfortunate occupant of a small and tightly-closed bed-chamber. The great objection to open windows and doors, is the uncomfortable draught which is caused by them. This objection is with many persons insurmountable, and there are numerous contrivances for otherwise giving entrance and exit to the atmosphere. One of the simplest is to have a portion of the window filled by perforated zinc plates or with perforated glass. The draught caused by air entering through small apertures is diffused and rendered less perceptible. But ventilation by this means is necessarily very imperfect. Another plan is that by the revolving tin fan still to be seen occupying the place of a pane of glass in some old-fashioned windows. Ventilators made of plates of glass which can be opened or closed after the fashion of a Venetian blind occupy the same position in some modern windows. These are in every way superior to the preceding, as they do not interfere with the light and the current of air can be directed either upwards or downwards.

Ventilation from below is effected by means of air-channels and grated openings in the floor, but it is disagreeable on account of the draught thrown upon the legs of persons in the room. A better method is to have the skirting boards of the room arranged so that spaces for the transmission of fresh air shall exist between them and the walls.

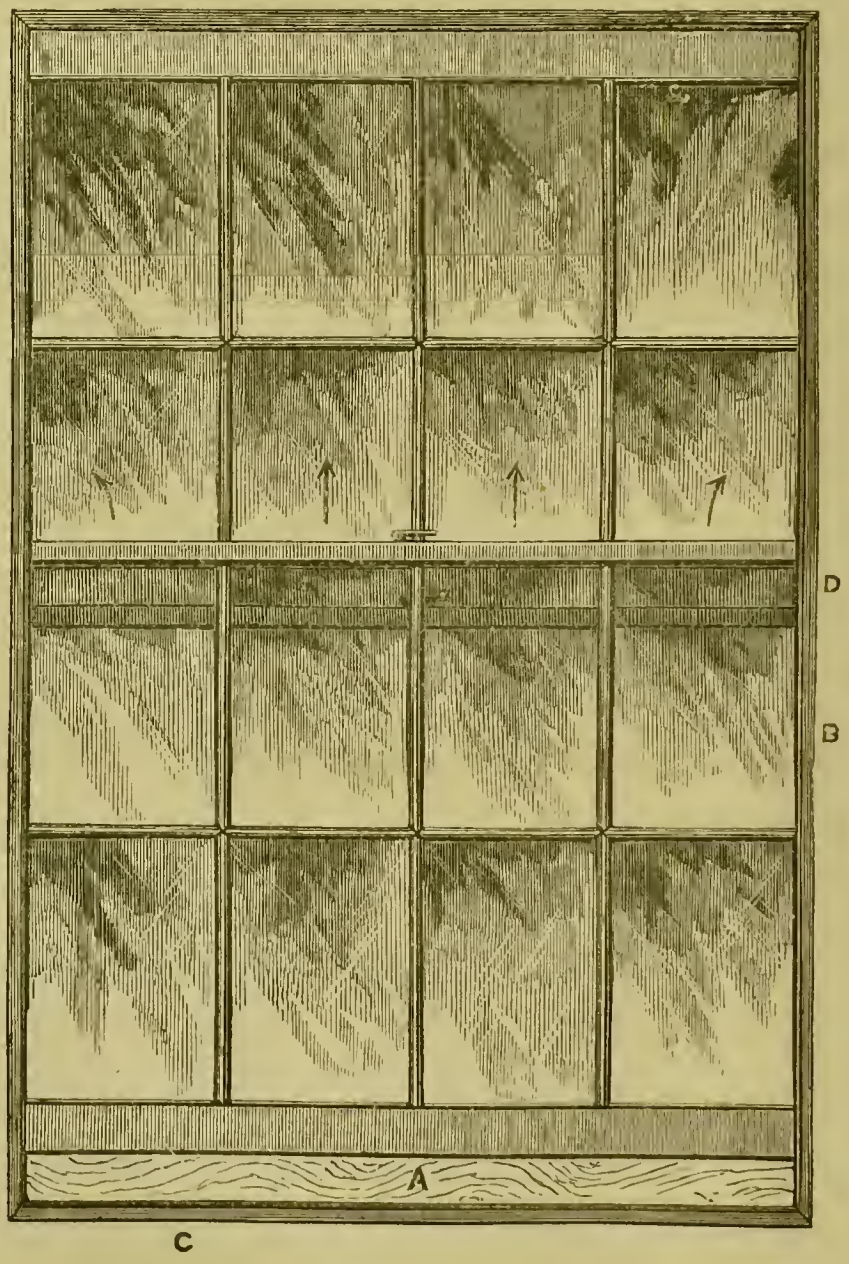
Arnot's valve ventilator, which is inserted into the chimney at some distance above the fireplace, is valuable because it is self-regulating, as all ventilators should be as much as possible.

Several methods of ventilating from the roof are employed in factories, stables, and other buildings. One method is interesting because it depends upon a curious property of the atmosphere. It consists in inserting, perpendicularly, into the roof a tube, which is divided longitudinally by a partition. One extremity of the tube communicates with the outer air, and the other with the room to be ventilated. It is found that the foul air passes out through one part of a tube so divided, while the fresh air passes in through the other part. A tube inserted within another tube, with a space between them, is sometimes substituted for the divided tube. But the objection to both methods is, that at the ceiling the fresh current in its descent into the room mixes with the vitiated ascending current.

We have now to describe one of the best and simplest modes of ventilating ordinary rooms with which we are acquainted. It is one equally applicable in winter and in summer, because all draught is avoided; for even if a window be opened at the top, a downward draught is frequently felt, and in rainy weather it is often impossible to keep the window open. The present plan is applicable in all kinds of weather, and would be perfect if the ventilation could be effected nearer to the ceiling.

As it can be applied at an expense of a few pence, and as no unsightly appearance is made, it is equally applicable to the cottage and to the mansion. A reference to the woodcut will greatly assist our description. A piece of wood (A) an inch or more in thickness, three inches wide, and exactly as long as the breadth of the window through which ventilation is to be established, is to be prepared. Let the sash be now raised, and let the slip of wood be placed upon the sill of the window: the sash is then to be drawn down closely upon the slip of wood (A). If the slip has been well fitted—and the fitting may be made more complete by adapting it to the grooves in the sash and its frame, if any exist—no draught will be experienced in consequence of the displacement of the sash at this part. The effect of such an arrangement is, however, to cause a

separation between the bars of the sashes at D. By this means perpendicular currents of air will be projected into the room between the glass in the upper and lower sashes and their respective bars, in the direction of the



arrows in the engraving, and other currents will pass outwards in the reverse direction, in a manner by which all inconvenience from draught will be avoided.

Supposing that two or more windows at opposite sides of a room are fitted in this manner, a very satisfactory ventilation will be provided. Owing to a difference in its equilibrium, the air will rush in on one side and rush out on the other side of the apartment. If the slips of wood are painted of the same colour as the windows themselves, they will attract little notice.

We cannot conclude the subject of ventilation without an appeal to clergymen, schoolmasters, and others who are in positions of authority. Immense good may be done by impressing upon the minds of those over whom they are placed, the vital importance of breathing pure air. Especially should this be instilled into the young. It forms as yet no essential part of a liberal education, that a man should be taught to understand the conditions upon which he lives, or how he should best preserve his health. Such knowledge is certainly not less important than most of the instruction he receives. Yet all the knowledge which concerns his physical existence is left to be picked up by chance, or to be gained by experience, an experience sometimes only obtained by the sacrifice of health. The subtle causes which vitiate the air we breathe, must, as we have seen, be sought out to be understood. And if this kind of knowledge is important to those who live in large and airy houses, how much more important is it to those

who pass their lives in humble cottages, and in the closely packed tenements of towns! How many head-aches would be avoided—how many a pallid cheek would be tinged with the glow of health—how many drooping spirits would be roused to the enjoyment of life—how many sickly infants would be transformed into vigorous men and women, instead of being prematurely cut off by disease, were the simple facts universally known and acted upon, that no kind of stimulant is so permanently enlivening, no food more strengthening, than a proper supply of fresh air in our houses.

It is a pleasant reflection, that within the present century, owing to many causes, but chiefly to the advancement of science, longevity has greatly increased in this country. We feel assured that a very considerable increase is still to be effected by a more widely spread knowledge of the principles and practice of ventilation.

VII.

THE LIVER AND ITS DISEASES.

The importance of the liver in the animal economy is great. It is present in all classes of living creatures except the very lowest in the scale. Few people are aware that the large soft portion of that delicious and now costly edible, the oyster, is nothing more or less than a liver. In the higher animals, its dimensions, although much less in proportion to the entire bulk of the creature, are still considerable. In man the liver is the largest gland, and weighs about four pounds, or about $\frac{1}{36}$ of the weight of the body. It is formed by an aggregation of very small masses, called lobules, each provided with blood-vessels, together with little tubes for carrying off the bile when extracted from the blood by the minute cells of which the lobules mainly consist. These tubes or bile-ducts, by their union, gradually go to form larger tubes, until the contents of all are poured into a single tube which passes to the gall-bladder or reservoir in which the bile is stored up for use. The gall-bladder is capable of containing about four ounces of fluid; it lies under the right lobe

of the liver, corresponding to a point a little to the right of the middle line of the body, and just below the ribs. This storing up of bile seems to be a convenience rather than a necessity, for the gall-bladder has sometimes been found, after death, to be quite obliterated, or else the entrance to it has been so blocked up as to render it practically useless. In certain kinds of animals too, such as in the horse and the deer tribe, no gall-bladder exists.

One of the uses of the organ is to separate bile from the blood. Certain carbonaceous substances are thus got rid of, and this is necessary for the purity of the vital fluid. But in the wonderful economy of nature, this otherwise waste material becomes subservient to the wants of the system. The bile is discharged from the gall-bladder by a duct which enters the small intestine at its upper part, just below its junction with the stomach. The secretion thus becomes mixed with the contents of the intestines, through their entire extent, and seems to be the natural purgative which prevents undue accumulation in the intestinal tube. Bile also prevents the contents of the intestines from fermenting. The operation of diverting the flow of bile outward through fistulous openings has been performed on dogs, and the animals have lived afterwards for years. The chief effects of such an operation are

voracity, flatulence, and a putrescent tendency in the contents of the intestines.

Human bile is a viscid, greenish-yellow coloured fluid, having an intensely bitter taste. It is alkaline, and it is to the alkalies which it contains that the bile of animals owes its cleansing properties. Bile would seem to be concerned in the digestion of fat, but how it effects this is not understood. The quantity of bile secreted in twenty-four hours is estimated at between three and four pounds.

The liver is subject to several diseases in common with other parts of the body, as, for instance, inflammation, cancer, and abscess, but the results are modified by the peculiar structure of the organ. It is subject also to particular affections which are due to the operation of special causes. There are two things which happen in most such affections—either the organ enlarges, sometimes to an enormous degree beyond its proper size, or it contracts below it.

No cause is so productive of chronic enlargement of the liver as heat. The hot climate of India is so frequent a cause of this disorder, that to come home with a big liver and a heavy purse was a current joke in the palmy days of moneymaking in that country. By the slow influence of climate the organ becomes engorged with blood and its functions sluggishly performed. The

result is seen in the muddy or even lemon tint of skin so characteristic of Indian residents, which is due to the imperfect elimination of bile from the system.

A preparation of liver (pâté de fois gras) is well known to epicures. But it is not equally well known that this delicacy is really the product of disease. At Strasbourg, where it is chiefly made, the geese from which the livers are obtained are subjected to the prolonged action of heat. It is alleged, on good authority, that the unhappy birds are nailed by the feet to boards, so as to enforce the necessary quietude during this inhuman process. But if the pleasures of the palate are the cause of so much heedless suffering, the unoffending creatures are not without some revenge. These diseased livers are far from being wholesome food.

The small or contracted liver in the human subject is usually the result of intemperance. The surface of the liver is covered by a stout membrane, called its capsule, and from this certain fine bands, or *septa*, pass through it between the lobules, so as to preserve the form and consistency of the organ. The effect of alcohol, absorbed from the stomach, upon these fine membranes is to induce in them a slowly-acting inflammation, by which contraction is induced. It results from this that the secreting cells of the liver are compressed and spoiled, and its surface, instead of being smooth and

regular, becomes elevated into nodules, not inaptly compared to "hobnails" in appearance. This is also well known to anatomists as the "gin-drinker's liver."

In order to make it clear how it is that spirit-drinking is so injurious to the liver, it will be well to explain here the peculiarity of the circulation through the organ. Instead of being supplied with arterial blood, like other parts of the body, the blood which goes to the liver is collected from certain abdominal viscera, chiefly, the stomach, the intestines, and the spleen, into a large trunk, called the portal vein, by which it is conveyed to the liver, and then disseminated through it by means of the small vessels already spoken of. After having supplied the liver cells with the elements to form bile, this blood is again collected by the minute branches of the hepatic veins, which go to form two large trunks—the *venæ cavæ*—by which the blood is returned into the general circulation. Now when fluids are taken into the stomach, they are absorbed directly through their coats by the veins which are so freely distributed over the inner surface of the organ. In this way alcohol passes at once into the liver, and it is for this reason that the free use of simulants, when the stomach is empty of food, is so pernicious. It is a matter of common observation, that spirit drinking, after dinner is less injurious than drinking before dinner.

Alcohol mixed with food becomes in great part blended with and carried by it into the intestines. It thus becomes diverted into other channels, and, having been taken up by the absorbents, if only present in moderate quantities, becomes digested and made subservient to the support of the heat and nutrition of the body.

The form of liver disease just described is very fatal, and is often attended by dropsy. It will be easy to understand why this takes place by considering what has been said of the circulation through the liver. The obstruction presented to the onward flow of the blood, through the contracted liver, causes engorgement of the portal vessel and its branches. These last, in order to relieve themselves, exude through their sides much of the *serum* or watery part of the blood, which accumulates in the cavity of the abdomen. This, then, is the mechanism of this form of dropsy.

It is no uncommon thing for the bile to produce spontaneously, by a partial decomposition, concretions either in the larger ducts of the liver itself or more frequently in the gall-bladder. These gall-stones, as they are called, so long as they remain stationary, usually give little trouble, and are sometimes found present after death, even of the size of a walnut, without their existence having been suspected during the life of the individual.

It often happens, however, that when of moderate size they pass out of the gall-bladder through the short duct of communication into the intestine, and in this manner are got rid of. The calibre of this duct is about that of a crow's quill, and the necessary distension to admit the passage of a concretion the size of a cherry-stone is slow and painful. Perhaps, indeed, there is no suffering to which the human frame is subject which exceeds that which occasionally follows from this cause. The only consolation is, that, happily, gall-stone is seldom a fatal malady. On the other hand, a person who has once suffered from it is very apt to suffer repeatedly. A common effect of gall-stone and also of some affections of the liver is jaundice. The name of this symptom indicates its nature. The skin assumes a yellow tint, which is regulated by circumstances. It depends upon the presence of bile in the blood, and the depth of the tint varies, of course, according to the amount. But, in addition to this, those who have fair skins present a bright lemon-colour, while in the dark-skinned a greenish hue is presented. In some instances, however, the bile itself is unnaturally dark, and then the appearance of the skin is darkened in proportion; such cases seldom do well.

The yellowness of skin is sometimes attended by almost intolerable itching; but generally there is no

sensation of the kind. The perspiration not unfrequently stains the linen bright yellow. The tears are yellow; but, most singular of all, sometimes the patient sees everything as if he were viewing all things through yellow glass. It proves that the humours of the eye, like the other fluids of the body, are tinged. To see things with a jaundiced eye is therefore no poetical fiction.

There are some curious statements connected with jaundice. *Icterus,* its scientific name, is the Greek term for the golden thrush, a bird having yellow plumage. Pliny informs us that the sight of this bird by a jaundiced person cured the patient, but killed the bird. It was called by the Romans the royal disease, as being one specially suitable for a king. Celsus, the famous physician of the age of Tiberius, tries to explain this. He says, it seems to be because, for the successful treatment of jaundice, all kinds of amusements are desirable, so that mind and body may be at the same time agreeably exercised.

It is a humiliating fact, that the human body is the home of many kinds of noxious parasites, which derive support either from the food we take, or else from the tissues of the body itself. Of the latter class is the so-called hydatid tumour, which is in reality a living animal which has been discovered in almost every part

of the body. The liver, however, is its chosen seat, as it is found here far more frequently than anywhere else. Strange as it may seem, hydatids are immature tape-worms, which, in the perfect state, are not more than a quarter of an inch in length, and inhabit the intestines of our domestic dogs. The eggs of these tiny, but far from harmless creatures, gain access to our bodies in the water we drink, or by some other means. It is not our purpose at present to follow the egg through the changes it undergoes, or the conditions necessary for the production of the perfect worm. It will be sufficient to state that the egg, having lodged in the liver, becomes developed into a bladder-like tumour, containing a clear fluid, and that it may attain the size of a cricket-ball, or even larger dimensions. It can be well imagined what a serious injury such a tumour must cause to the liver. Fortunately, in this country the disease is comparatively of rare occurrence. Nor is it necessarily one incapable of relief, and even of permanent cure. The tumour is sometimes tapped by the surgeon with complete success. Nevertheless in Iceland, where, from local causes, the disease is extremely common, it is the source of a large proportion of the total mortality of the island.

Having now given a rapid sketch of the more serious diseases of the liver and its appendages, we have a few

words to say about those which are, in a popular sense, more important, because more common, and because great mistakes are constantly made on this subject. Functional disturbance of the liver, as known by diminished or irregular secretion of bile, is certainly not unfrequent. Sometimes this is associated with pain in the right shoulder, a sense of fulness and tenderness on pressure under the ribs on this side, with or without the presence of a tumour in the same position, showing the liver to be enlarged. These symptoms especially belong to persons of a certain aspect—sallow, sunken-eyed looking people, ordinarily termed bilious subjects. But nothing is more common than to hear people say that they are *bilious,* which means, if it means anything, that they are suffering from some fault in the quality or the quantity of the bile. It must also be admitted, that many members of the medical profession too often apply the term carelessly, or else adopt too hastily the statements of their patients. The fact is, that in nine such cases out of ten, it is simply the stomach which is misused. Healthy people oppress their stomachs by eating and drinking a greater mixture of things, and in greater quantity, than they can possibly digest; or else, the digestive power being weak, they indulge more in the way mentioned than the stomach is able

to receive without injury, although, if healthy, no bad consequences would result. In either case various unpleasant sensations are complained of, and the whole is summed up by declaring, as already said, that they are "bilious." Now there is a traditional notion that a "blue pill and black draught" are the only true remedies for biliousness. The pill, as most know, consists of mercury, and the draught is a strong purgative consisting of senna and Epsom salts. This rough treatment relieves the effects of accidental indigestion, that is to say, of indigestion induced by excess in healthy persons. But its frequent repetition is very injurious; inducing permanent disorder of digestion, besides other bad results that attend on the introduction of mercury into the system. It will be seen that the misuse of terms is here, as in many other cases, a serious evil. The best of all courses in such ailments as those last mentioned, would be avoidance of the exciting causes. But when people attribute to the harmless liver what is in reality due to the stomach, it does not occur to them to be as careful about diet as they would be otherwise. So with regard to immediate treatment; while abstinence, in order to rest the stomach, and at most some gentle aperient to remove offending materials without violence to the organs, would be only necessary, the blue pill and strong draught are swallowed

because custom, and sometimes the doctor, requires that the assumed bilicusness must be met in this particular manner.

We have said nothing about the treatment of diseases of the liver, because, as a rule, they require measures only to be undertaken by the medical practitioner. Mercury in judicious hands is undoubtedly a valuable agent in this class of diseases. Nitro-muriatic acid or *aqua regia*, that active agent which dissolves gold itself, is also highly useful. Amongst the more harmless drugs, and one which may therefore be used freely by the unskilled, *taraxacum*, which is extracted from the dandelion of our fields, holds a place. The freshly expressed juice of the herb may with advantage be substituted for the prepared drug.

VIII.

THE ACTION OF ALCOHOL.

Our object in this chapter will be to teach the physiological effects of alcoholic liquors, in order to afford guidance in use of alcohol; and to exhibit the changes wrought in the human body by spirituous liquors taken in excess, that alcoholism or the abuse of alcohol may be understood.

The health both of the individual and of the State begins to excite some little national solicitude; but the appeal to State interference in such matters, must come at last from the people themselves. It is easy to make laws, but difficult to enforce them, unless the large majority of the nation understand the benefits to be derived from obedience. But we are not in the ranks of those who would remove the tax on spirits: a tax whereby the poor as well as the rich are made to contribute to the expenses of Government by paying a price above its production cost for an article of luxury; and very far are we from siding with those who misinterpret the liberty of the subject to mean

the right of any man to wrong his neighbour; to sell him fictitious goods—poison perchance for food.

Need we preface our remarks further? Yes; lest certain persons, wearied by the repeated bugle calls blown by the trumpeters of total abstinence armies, should shoulder arms and march away from us. We are no abstainers ourselves, and we are not about to advocate teetotalism under the banner of physiological instruction. It is as Physicians we speak; the flag we hoist has a white ground with a broad red cross upon it; we hold ourselves aloof from the fray; both armies send their shot into our tent; if we are attacked we know it is by ignorance or misadventure; we succour both parties alike.

Come, tell me, cries some philosopher, a poser of questions, "Is alcohol food or poison? for herein lies the gist of the whole matter."

Nay; not altogether, we think. But those who ask us questions will get questions also in return. Can alcohol fail to be a food when in states of habitual intemperance, in diseased conditions of the body, as in fever, a man lives sometimes for many days together upon spirit and water alone? Surely that thing is rightly called a food upon which life can be maintained.

Arguments clinched thus easily by superficial questions mutually leave both sides dissatisfied. We had

better far give up the time, and work out the problem we seek to solve by studying the facts together.

We must premise a few words upon the composition of alcohol; we shall then follow its journey through the human system, noticing its way of entry, distribution, appropriation, decomposition, and separation from the body.

Hydrated oxide of ethyle is a chemical synonym for alcohol. It is the substance formed when ether and water are made to combine with each other, which under fixed chemical conditions they will do; or, practically, when any substance containing sugar or glucose is fermented, or broken up by the decomposing action of the yeast plant growing in it. The living vegetable, undergoing change itself, disturbs the elements—the carbon, hydrogen, and oxygen—of which the sugar is composed; and these proceed to re-arrange themselves as carbonic acid and alcohol, volatile oils and acids.

The fermenting liquor called *must* in the instance of grape juice, *wort* when the saccharine principle is derived from some grain, furnishes always those two chemical products, carbonic acid and alcohol; the former passes into the air or is partly held in solution by the mother liquor, the latter, alcohol, is capable of separation by distillation. Being more volatile than water, spirit distils over, and is most pure in the portions that distil over

first. It is more mixed with volatile oils and free acids towards the end of the operation; but whether emanating from grape juice or grain, alcohol can only be obtained pure by redistillation.

Its flavour varies of course with the mother liquor out of which it is formed. As an article of trade, the purest alcohol is chiefly employed by the manufacturer of scents; the next pure is employed in medicine. The third quality forms the spirits of ordinary commerce, mixed with the oil of wine, or œnanthic ether, as in brandy; or mixed with fusel oil, as in gin and whisky, spirits derived from grain. The last or worst, because most impure qualities of spirit, are we are told used chiefly in the manufacture of varnish; although some very evil spirits indeed are exported to distant lands to be consumed by savage tribes ignorant of what is better.

In all wines and beers the alcohol-containing liquor contains some nitrogenous materials, furnished by the ferment and the mother *must* or *wort*, some sugar, certain volatile oils, some acetic acid and carbonic acid, the latter conferring its agreeable briskness to all fermented liquors.

Let the alcohol come whence it will, its purity and strength modify greatly its effect upon the human economy; and, as experience has taught mankind, the

digestibility, agreeableness, and amount of nutrition to be derived from the various alcohol-containing fluids is very far from uniform. Still certain physiological effects are due to the alcohol in any spirit-containing mixture that is drunk; and these we shall proceed to describe, premising only that they vary with the strength, and the quantity of the dose.

Experiments have been instituted to ascertain the local effect of strong, as well as of diluted, spirits when applied to transparent and highly vascular membranes. The mesentery of a mouse, the wing of the bat, the web of a frog's foot, can be thus treated and examined under a microscope.

The diluted spirit renders the membrane more vascular. The living particles called blood-cells course more rapidly than before through the vessels, and minute blood-channels are rendered apparent in parts which looked previously quite homogeneous.

If, however, a drop of strong spirit be brought in contact with the membrane, a totally different series of changes ensues. The walls of the smaller blood-canals contract, the passage is constricted, the blood-particles are obstructed, and, after a little oscillatory movement, the stream stops altogether; then the membrane becomes opaque, and shrinks. In the part thus injured the circulation is never restored; and if the life

of the animal is maintained, the maltreated portion ulcerates.

When, however, diluted alcohol is used, and any tissues are thus rendered more vascular, they become warmer, because more blood passes through them, and the blood-cells themselves swell in size by reason of the alcohol and water permeating the walls of the vessels and passing into the current of the circulation.

Alcohol, then, if sufficiently diluted, quickens and replenishes the circulation; if too strong, it acts upon living as on dead tissues, absorbing or appropriating the water of which they are composed and coagulating their albuminous contents. The throat and stomach are protected against the coagulatory action of strong spirituous liquors by their surface moisture, and the free and constant flow of blood through their interstices, which yield water by exhalation until the spirit is diluted enough to admit of being absorbed into the veins.

It is astonishing how far the force of habit goes in enabling soft and vascular tissues, like those which line the throat and stomach, to sustain the assault of a fluid strong enough in alcohol to be readily inflammable, and which would shrivel them up if kept long undiluted in contact with them.

Alcohol passes into the blood direct through the walls of the smallest vessels. It cannot be fairly said to be

digested. It suffers little if any chemical change by being mixed with the digestive juices of the stomach and intestines. It is not absorbed through the same channels whereby the food gains access into the blood. The *villi* do not take it up; the lacteals contain no appreciable trace of it. It is carried, diluted but unchanged, through the veins into the liver, and thence into the heart and through the lungs, and thus into the arterial circulation.

Let us now watch a little more closely the effect of alcohol in the blood. First, upon the blood-vessels themselves—the pump and pipes by which the circulation is effected—and then upon different organs through which this blood is conveyed.

We have observed that the blood-cells are rendered slightly larger by being bathed in a diluted alcohol-containing fluid; the blood-vessels are also somewhat dilated by accession of more fluid into them; the heart's action becomes quickened, and its contractions take place not only more rapidly but with increased vigour. The blood is driven more quickly through the lungs, and the respiratory acts are proportionably accelerated. We have only to watch the face of a person who has drunk a full dose of wine or spirits, to verify all these things. The smaller blood-vessels in the cheek, or those which traverse the white of the eye,

lie open to inspection; the face becomes flushed because these are more turgid, the eye is injected from the same cause; while the fact of larger blood supplies being conveyed to the surface of the body is further testified to by a very slight elevation of the skin temperature at the extremities of the body, which a sensitive thermometer will show.

The general sensation of warmth and well-being perceived shortly after a dose of alcohol has been taken, admits, then, of ocular demonstration. If the blood, however, be overloaded with alcohol, the surface temperature of the body falls.

We turn our attention next to the effect of the spirit upon the organs through which it passes.

The veins which absorb the diluted alcohol from the stomach and intestines, carry it directly through the liver. This organ, therefore, sustains the first and heaviest assault of the strongest alcohol and blood mixture; and if alcohol be injurious to the economy, this viscus will suffer accordingly, a circumstance we may have occasion to revert to and prove hereafter.*

When the blood, thus laden, reaches the air-cells of the lungs, a considerable quantity of spirit is exhaled in the

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* Few of our readers, we think, will fail to have heard of the gin-drinker's liver. "He died of dropsy and diseased liver, a' from the drink."

breath. The volatile oil mixed with it gives the expired air the smell of the liquor drunk; but the actual presence of alcohol admits also of experimental demonstration. If the breath of a person who has drunk so little even as a glass of light ale, containing three per cent. only of spirit, be conveyed through a test solution of chromic acid, the presence of alcohol can be attested by a distinct colour change.*

That the alcohol drunk has gained access to every part of the body through the medium of the blood, can be shown by its detection in the sweat and in the urinary secretion. By all these portals, then—the lungs, the sweat-glands, the kidneys—the alcohol is slowly eliminated. As to the quantity which thus escapes, the quantity appropriated as food and consumed, and the quantity merely combined and stored away, we possess as yet unfortunately no exact information.

Part of it, we know, is carried off through the alimentary canal as waste,—is never therefore taken up into the blood at all; but the greater part by far is absorbed into the circulation. Of this a portion is exhaled, a portion also is excreted by the channels above mentioned; but a portion, and this a large one too, we

* The exact composition of this test-solution is one part bichromate of potash in 300 of pure sulphuric acid. Its delicacy is so great, that the presence of $\frac{1}{120}$ of a grain of alcohol can be detected by it.

believe, is broken up into water and carbonic acid, and thus consumed, as Liebig originally surmised, either in the blood, by the action of the red cells, or in the liver, or in the nutrient changes in the interstitial tissues of the body, perhaps in each and all these places; or, if not thus consumed, it is converted into fat, and thus appropriated to the uses of the economy.

Although taken into the circulation rapidly enough, alcohol is but slowly eliminated from the system, and is probably only very slowly appropriated. Particular organs or tissues of the body exhibit especial affinities for it. They seem to hold it as a sponge holds water. The brain and nervous tissues, the liver, and the blood seem specially capable of holding or storing it; so that if an animal which has been overdosed with spirits be killed some hours later, and its body examined, not only do the brain, liver, and blood smell strongly of the spirit administered, but this can be recovered from them again by a process of distillation. The relative quantities of alcohol which equal weights of these three tissues thus furnish, prove that the brain substance holds more alcohol than the liver, and the liver more than the blood—a circumstance of extreme interest when the effects of chronic alcoholism come to be considered.

Two physiological effects, distinct and opposite, have been attributed to alcohol—an early stimulant, a later

depressent action. To explain these, several theories have been mooted. All excitation, it was said, means more rapid oxidization, quicker consumption of nutrition, greater wear and tear of tissue: if the heart's action at first be quickened by the stimulant action of alcohol, this organ must shortly suffer fatigue, the circulation will then become retarded, and the sense of depression be felt. Similarly, of the nervous system it was affirmed—exhilaration means what our American cousins call rapid brain-functioning, living too fast for repair; for the nutritive processes require time, and cannot be carried on so quickly as the expenditure of force.

There is something true in the theory thus enunciated, and framed no doubt to meet the occasion. Fatigue does follow over-exertion of mind or muscle, and is evidence that the processes of repair have not taken place so quickly as those of destruction. But the idea that life and energy are antagonistic things involves fundamental error. Energy, or the manifestation of power, the conversion of force into action, involves no expenditure of life or loss of power. Thinking or lifting a weight is but a function of tissues provided to issue thoughts or actions. The tissues do not suffer by reason of their employment, so long as their nutrition is maintained. Brain and muscle can be very fairly likened to machinery, instinct

with power but requiring nourishment, as the engine needs fire and water in order to be put in motion. Both require food in order to perform their functions; but there is this difference between them—the engine may lie by, yet not suffer, but the nutrition of brain or muscle is requisite that these may live; and perfect nutrition—the appropriation of what is needful, the removal of what is harmful—cannot be maintained unless the organs themselves be exercised.

The employment of his mind or of his hands does not wear the life out of a man, except the work be performed under conditions for which the machinery was never constructed. The human body was made for labour, and parts which are not employed quickly degenerate; indeed, we believe more men wear out through indolence than by strain of overwork.

But to revert. The temporary exhilaration conferred by alcohol is termed its stimulant effect; a sense of well-being is diffused all over the body by the greater fulness of the blood-vessels and a more equable distribution of animal heat. Nor is this sense of comfort followed of necessity by any depression, so long as the alcohol has not been taken in any excess; if, however, it accumulate to any extent in the blood, the nervous tissue suffers impaired nutrition, and exhibits its fatigue by mal-functioning.

As we shall hereafter have occasion to insist, alcohol cannot be called anything else but a food, for it contains certain elements by which the body can be sustained; but it is not difficult to show that it is a dangerous food, and one that should be very sparingly employed.

Itself a feebly oxidized body, its desire is to combine with oxygen, until, as chemists say, it obtains more chemical stability, or is decomposed into water and carbonic acid.

Now alcohol mixed with the blood conducts itself in no way differently to alcohol in the chemist's laboratory; and just in that degree in which the blood is loaded with alcohol, it may be pronounced to be deprived of its free or combinable oxygen; it is more highly carbonised, more charged, that is, with carbonic acid, more venous, and less capable of effecting those chemical interchanges which render it the medium by which nutrition is carried to each remote corner of the body, and by which the bodily heat is maintained. Now a highly nutrient blood, one that can yield its oxygen liberally, is essential to the vitality of the brain and nervous centres; these cannot perform their manifold functions unless they are well nourished. I have not space to dwell upon the evidence of this, but the fact is one well recognised by all physiologists.

The enervating influence of close, ill-ventilated rooms, and the drowsiness induced by the respiration of atmospheres overloaded with carbonic acid, are homely but apt examples of this susceptibility of the brain to suffer in its nutrition.

If an animal be deprived of oxygen, if it be exposed to an atmosphere surcharged with carbonic acid, its blood quickly becomes purple coloured, and fails to nourish the brain. At first the creature becomes drowsy, then comatose, is not infrequently convulsed, and finally dies asphyxiated, the heart gradually ceasing to act because the circulation through the lungs has come to a stand-still.

Laughing gas, chloroform, ether, alcohol, all procure anæsthesia, with different rapidity it is true, but by one common action, depriving the cerebral centres of the oxygen essential to their nutrition, and poisoning them with the carbonic acid whose quick removal is equally needful to hinder disturbance of their functions. That anæsthesia is produced in intoxication, any one who has seen a drunken man fall and cut his face, or strike his knuckles against a wall will be ready to believe.

Alcohol then deprives the blood of its free oxygen, and, in consequence, the brain suffers partial paralysis of its functions, chemical interchanges are diminished

all the body over, combustion is retarded, and the animal heat is depressed.

We proceed next to examine the symptoms of that peculiar brain paresis, or palsy, which is produced by alcohol in the circulation, since the manner in which the higher intellectual operations of the mind are first assailed, then starved, and finally annihilated, while the lower situated nerve centres exhibit greater powers of resistance to the evil effects of a partially de-oxidised blood, is of great physiological interest.

Among the facts which the physiologist for many years past has been in a position to deduce inferentially, none have appeared to him more important than those which led him to attribute different functions to different portions of the brain and spinal cord; the exact allotment of their duties to the several parts was, however, by no means an easy thing to determine. The experiments made involved rude injuries, and were but rough guides to truth; latterly, however, a new mode of questioning nature has been discovered; what was formerly guessed at has been established upon more reliable proof, and much which could not be ascertained by the older methods is likely to be made known to us.

It appears certain that some portions of the brain substance are set apart by habit, and, as it were,

educated to preside over particular intellectual operations. Thus we are fairly entitled to conclude that there is a thought-apparatus, which furnishes ideas, remembers, compares, judges, exercises control over the emotions; that there is a receptive apparatus, which receives and stores impressions derived from the special senses, which feels, smells, sees, hears, and tastes, through organs provided for these several purposes.

Then again, there are nervous centres whose duties are to co-ordinate complex muscular movements, as of the two eyes, that vision may be single; as of the tongue, that speech may conceal and reveal the thoughts; as of the hands, that those may wield a pen or play a piano; as of the legs, that those may poise the body in running or standing; as of the trunk, that the upright position may be maintained.

And lastly, we must make mention of those lower situated nerve centres which co-ordinate the movements of respiration and the rhythmical contractions of the several cavities of the heart. It will be perceived that the human body is like the Prussian Government, a very perfect bureaucracy; its direction offices are manifold; each has strictly defined duties to perform, all have to report progress and to receive orders from one presiding head-centre.

After this apparent digression into general physio-

logy, we may proceed to illustrate the several phases of intoxication or brain-poisoning with alcohol, with some hope of making them intelligible.

One of the first, if not quite the earliest symptom which can be accepted as evidence that certain nerve functions are impaired by the circulation of a blood oppressed by alcohol, is flushing of the face and of parts of the skin. The same thing is observed in blood-poisoning during fever. The interpretation of this phenomenon usually given is a partial paralysis of the cranial and cranial sympathetic nerves, whose branches are supplied to the walls of the arteries, and whose duty is to adjust the blood supply to the requirements of nutrition.

This symptom is seen equally in intoxication by ether and by alcohol: certain blood-vessels become dilated, more blood passes through them, and the skin surface supplied by them becomes flushed, and exhibits a rise of temperature. A rise of $3\frac{1}{2}^{\circ}$ Fahr., as Dr. Anstie's experiments show, can thus take place in the ears of rabbits and guinea-pigs.

Simultaneously almost, due perhaps to the same cause, the eyes are perceived to be slightly protruded from the sockets, and obtain a brilliant glistening look. And now it is (in human kind) that the hold which a man's judgment ought to exert over his imaginative

faculties begins to be relaxed, and the phenomena of nerval excitement are exhibited: ideas follow each other quickly, and exhibit exaltation or depression according to a man's habit of thought; his tongue, too, is loosened, and becomes an excellent index of the degree in which mal-nutrition of his intellectual brain-centres has influenced the operations of the mind. He brings little Egomet into the foreground; it is self-praise, self-depreciation, his mother wit, his natural talents, his proverbial luck, his personal endowments or adornments, but self, self, self is the character that never quits the stage. He is precise, communicative, loquacious, garrulous, twaddling, and at last babbling in his talk.

It is of course in this semi-delirious condition that different natures show themselves, illustrating the *in vino veritas*, of which so much has been said: how the gentlest creature alive becomes doggedly authoritative and provokingly contradictory; how the timid man is emboldened to adventure; how the individual to whom reserve was habitual, lays bare his profoundest secrets to the friend of an hour's acquaintance.

In this stage of intoxication, it is not that ideas are wanting any more than muscular force, but that the faculty of co-ordinating those complex intellectual operations, which together make up the mind and cha-

racter of the individual we were wont to know, is faulty; judgment is impaired before memory, emotional control is lost, and the passions stalk forth,—the moral sense and power of voluntary recollection are lost. The well balanced Egomet has lost all the benefit of its worldly schooling. The coarse vulgar foundations, upon which a highly finished superstructure had been reared, crop forth to our disgust; the lower nature has predominance.

Further evidence that all this is the result of partial paralysis of one portion of the brain-substance before another will be shortly forthcoming. But a fact in illustration may be advanced. In man as well as in animals, more or less anæsthesia of the skin of the face accompanies, we are told, an early stage of intoxication; it is due to a partial paralysis of the fifth cranial nerve, which supplies sensation to these parts. The skin about the muzzle of dogs loses common sensation. The affection of the cranial sympathetic, as evidenced by the flushing of the face, we have already dwelt upon; while so soon as the stage of alcohol narcosis is reached, the hypoglossal nerve, which co-ordinates the movements of the tongue, becomes partly paralysed, and speech is affected.

The stage of intoxication which is characterized by cerebral mal-nutrition and nerval excitement passes, by

insensible gradations, into that of narcosis, or drugged sleep. The special senses, taste and smell, become impaired somewhat early, so that a connoisseur cannot distinguish one wine from another. The eye, too, loses its cunning, its muscular movements, like those required of the tongue in speech, failing in that exquisite adjustment and harmonious working which is requisite for single and perfect vision; the nerve centres, whose business it is, without any effort of volition, to balance and control that delicate motion, being either partially or wholly palsied.

Curiously enough, as in the delirium of disease, and in the mal-functioning provoked by the mal-nutrition of insanity, the organs of vision are far more prone to play their owner tricks—see that which is not, and misrepresent that which is—than either the sense of hearing or that of touch. Thus for a long time after a drunken man's speech has ceased to be articulate, or his eyes to convey correct impressions, he may be induced to gather his semi-consciousness together at hearing his own name called.

In our description of the physiological effects of alcohol, we have now made our readers acquainted with three stages: a first, of stimulation, a second, of delirious excitement, and a third, of narcosis or partial brain palsy. This palsy may become more and more

profound as the paralytic influence extends over the nerve-centres which control the movements of the limbs, and administer to the functions of mere animal existence, such as the respiration and blood circulation; but it is desirable to separate this state of advanced palsy from that of narcosis, and to call this a fourth stage, or stage of coma.

Throughout the stages of stimulation and excitement it appears certainly the rule that the skin is hot and drier than natural; but when the narcotic stage is passing towards that of coma, a sensible perspiration usually bedews the forehead and cheeks, and this becomes apparent just when two other usually associated symptoms are observed, namely, giddiness, or vertigo, and vomiting. During the stage of narcosis the pupils are natural, or rather contracted; but in that of coma they become dilated. It is in the stage of narcosis that the power to regulate the movements of the legs becomes impaired, but the power to support the body is not wholly lost until the stage of coma is reached. In cats and dogs made drunk with spirit, the same series of physiological symptoms are manifested that are observed in man. The hind legs first lose power, and the animal struggles to stand; finally they give way altogether, so that the creature falls, paralysed both as to power of motion and sensation in those parts, while still

retaining sense to struggle forcibly with its fore limbs. Thus a drunken man is often seen supporting himself by his arms when his legs are perfectly useless to him.

It is in the stage of narcosis that convulsive movements not infrequently affect the muscles of the arms and face. When an animal falls down from paralysis of its hind legs, drowsiness overcomes it; a like thing is seen in the intoxication of man: he falls asleep, and will sleep for some hours a drugged heavy sleep. This is not necessarily coma, in the physiological sense we attach to the term.

All intoxication does not reach the stage of coma, which is vulgarly called the state of dead drunkenness. This condition is exactly similar to that produced by an overdose of chloroform, and is one, of course, of imminent risk to life; in it a man lives only by the pertinacious resistance to poisonous impressions exhibited by the great ganglionic nerve centres, situated at the uppermost portion of the spinal cord. We shall describe the symptoms most characteristic of the stage of coma, which ought to be better known than they are, for not a few persons are allowed to die in police-stations and elsewhere every year, those who pick them up not recognising the symptoms of most dangerous import, which serve to distinguish this state from that of mere intoxicated sleep or narcosis.

In the stage of coma, the pulse, previously full and slow, becomes small, running, and almost imperceptible; the face is pale, the surface of the body cold, for the bodily temperature is now universally depressed. If the arm be pinched, it is not moved; if the eyeballs be touched, the eyelids are not winked; respiration becomes slower and slower; the lips become livid; and death, if this takes place, happens either by syncope, the heart ceasing to beat, or, as is more usual, by failure of breath through gradual stagnation of the circulation through the lungs, in which case the lungs after death are found gorged with blood, and the right half of the heart is fully distended.

People have been said to die of cold in this comatose stage of intoxication. This much is certain, that external cold has the effect of quickening the process of intoxication; as is well known, a man who was previously only slightly excited by liquor, by going out into the cold air in frosty weather may quickly fall in a state of narcosis, become comatose, and die.

Furthermore, in the stage even of narcosis, the circulation of alcohol through the brain-centres certainly has the effect of lowering the temperature of the body. It is scarcely true, however, to conclude that the man who is found dead in the open air, and who is known to have been drinking previously, has died from the

effects of exposure to cold alone; rather should it be said that he has died from the poisonous effects of an overdose of alcohol promoted by external cold.

To recapitulate: we have described four physiological stages of alcoholism, not strictly limited, seldom distinctly observed, for the one verges by scarcely perceptible gradations into the other.

For its stimulant effect, in extreme fatigue, in disease, and especially in fever, the physician employs wine or brandy to steady the heart's action and invigorate its contractions; he perceives that the alcohol is useful in diminishing perspiration and excessive secretion in states of great weakness, that neuralgic pains are relieved by it, and tremor and spasm of muscle are temporarily abated.

But it is not merely for its stimulant effects that he prescribes, and allows, the sparing and careful employment of alcohol-containing liquors.

Nearly all of them, as wine and beer, contain other nitrogenous materials as well as alcohol, and are strictly foods, with just that amount of stimulant combined with them which makes digestion easy and nutrition more complete. The man who gives up taking beer or wine with his food can maintain himself quite well without them, but he will eat more bread, more meat, and more vegetables, and he will require more time for his meals,

being able to exert himself neither quite so quickly nor so vigorously after them.

But all alcohol-containing liquors are foods to be taken with discretion and extreme caution. It is not every habit of body that can bear them at all. They are foods which should be reserved for extraordinary service, for special conditions of disease, and for impaired health. They are truly serviceable only when nutrition is disordered, when one part is living too fast, another too slowly, when a man is suffering from some disturbance of his normal balance, or when he is maintaining life upon conditions unfavourable to health.

That fermented drinks are useful articles of food, the history of man upon the earth, who has certainly employed them from the earliest ages and not deteriorated under their habitual use, as well as the universality of the instinct which has prompted mankind to consume them, may be held to testify.

Strong liquors and spirits, even the stronger wines, may find their fitting place as medicines, but as articles of food cannot be regarded as other than dangerous; and this because the quantity in which they can be taken without producing harm (the dose, that is) will be found to vary with climate, temperature, and the individual state. The stronger any liquor is in alcohol the less claim has it to be called a good food itself, and the

more certain is it to diminish the appetite for the more valuable flesh-making nitrogenous materials which ought to enter into any dietary calculated to maintain all the organs of the body fully repaired.

There is a habit of petty drinking which we must notice here to condemn. It is vulgarly called "*nipping*." The very name has a mischievous clink about it, implying sharp twinges made on a sudden.

Both men and women practise it,—men at their offices or at their work, ladies in the midst of their domestic duties, or at their amusements. The fatigue of overwork, the *ennui* of mere indolence, alike prompt to it. Men usually employ a glass of sherry, women take ether, eau de Cologne, or sal volatile; but the object is one and the same,—to goad what have become, through lack of healthly nutrition and fair treatment, torpid nervous energies. The individuals who thus resort to alcohol for its influence upon their nervous systems fall into the vice of dram-drinking almost unawares.

One, at least, amongst the many risks attached to fermented liquors, as adjuncts to other food, is their quick assimilation, their very easy appropriation by the body, and the facility with which they staunch the sense of hunger. Thus they are employed often to save time, which a more solid meal would require in consumption; and the principal meal of the day, which can never be

dispensed with if health is to be consulted, is postponed until the evening, when the body is fatigued, and requires repose rather than food, and certainly rest before taking it.

The professional man who, after a day's fatiguing brain work, comes home to a late dinner, has more relish for wine than food; so too the labourer who has foregone his mid-day meal, and taken ale in lieu of it, sits down with little appetite to bread and tea, or meat, but craves for spirits, which will relieve his immediate sense of lassitude, but can scarcely refit his frame to endure another day's labour.

But spirituous food in such cases is attended by risks of all kinds: first, there is the temptation to take the alcohol mixture stronger and stronger, that the sense of fatigue may be more quickly subdued; then there is the inclination to drink liquor before any food is put into the stomach, by which the process of digestion becomes impaired; and lastly, there is the great likelihood that an excess of liquor will be taken, for while the nutrition which is required is quickly furnished, the sense of refreshment which is derived from a natural meal composed of varied aliments is not obtained; thus the individual is prompted to take more alcohol than his body can with safety support and appropriate, and he severely tasks his eliminant organs in removing, not

merely the daily waste of his tissues, but an excess of wasteful food. This, too, without even approaching to a manifestation of the symptoms of intoxication. It will be readily understood that the bodily coffers are loaded without being enriched by treasure of this kind, and that by the help of alcohol, taken not as a sparing adjunct but as a main staple of food, a man will be encouraged to live upon the capital of his physical energies instead of on the interest; interest which his organs, more fully nourished by other aliment, would have liberally furnished him.

All foods are stimulants, and all stimulants are foods, and the distinction sometimes drawn between them is not merely fanciful but strictly untrue; furthermore, we might inculcate a doctrine that we are well aware every physiologist would endorse: That any food taken in excessive quantity is a poison, that is, acts prejudicially to health, disturbs and damages the body.

Before concluding this sketch of the physiological effects of alcohol, there is a matter which we feel it our duty to insist upon, namely, that while all alcohol-containing liquors are dangerous foods, and for the great mass of mankind are quite unnecessary, yet as medicines they are fraught with special powers, and possess qualities of such value as need to be pointed out,—this, too, especially at a time when we hear of the institution of a hospital where no alcohol is to be admitted.

Alcohol in the blood, as alcohol outside it, is an antiseptic agent of singular power. In states of blood-poisoning and fever it lessens the tendency of the blood itself to break up, and of the living particles, the cells in it, to disintegrate; it promotes the consolidation of the tissues of the body, when these are prompted by some fermenting disturbance, as in fever, to swell up and incorporate more water than they require. It, further, in fever retards that very consumption of tissue which constitutes the pyretic or febrile state, arresting, as we have shown, all chemical interchanges between the blood and the tissues, by its own more vigorous action as an oxidising agent.

Magnus Huss, in his work on Alcoholism, classifies individual temperaments according to their several proclivities to exceed in drinking, and to suffer from the action of alcohol. First, because most mischievously affected, he places the sanguine nature; second, the bilious; third, the lymphatic; and last of all, the nervous.

It is well known that the inhabitants of cold and damp northern climates are, in respect of consuming liquor, the chief sinners; the Italian and Spaniard, inhabitants of hot and sunny climes, and living beneath blue skies, being broadly and generally speaking sober people. Their energies are perhaps too active to need further stimulation.

Our own experience has taught us that the temperament which in this country appears most prejudicially affected by alcohol is the sanguine. Plethoric persons, although strong-headed, and able to carry, as is said, unusual quantities of spirit without being intoxicated, exhibit small power of self-control in drinking, and suffer accordingly.

Those again who inherit an unstable mental equilibrium, irritable, excitable persons, and epileptics, should abstain from alcohol as rigorously as from very poison. Contrariwise, the lymphatic, the over-large, pale, apathetic personages find good wine and beer, not only their best medicine, but a useful adjunct to their dietaries.

There are writers who attribute all the ill effects of alcohol to the impurity of the liquors drunk, the amount of fusel oil, œnanthic ether, volatile oils, and acids in them. These people remind us of the *bon vivants* who attribute their headaches and parched tongues to the soup, the fish, or the sweets.

That certain adulterations and impurities, which provoke thirst, and so excess in drinking, are wickedly pernicious, we are quite ready to concede; but that fusel oil is the principal deleterious agent in spirits, or that the brain suffers especially from it, and not from the alcohol, we see no reason for believing.

But into the long category of more or less poisonous

alcoholic mixtures we have no intention to enter. There are tinctures of certain herbs, as absinthe, and liqueurs, as vermouth, which it is likely enough exert some special deliriant effects upon the brain, acting in this particular like Indian hemp, henbane, stramonium, belladonna, camphor.

Some wines inebriate more rapidly than others; others deteriorate the digestion especially. Light sparkling wines make people cheerful and talkative, heavy wines and beers render them morose and sleepy; but these are general facts which we have not time or right to discuss more minutely under the action of alcohol.

IX.

MUSCULAR MOTION AS EXEMPLIFIED IN THE HUMAN BODY.

There are two things in which most men believe—*force* and *matter;* but the one is so intimately blended with the other that, apart, we can hardly, if at all, recognise them. Now, of late years, since the sciences called the natural sciences have been more and more studied, men have set themselves to work to investigate what is called force, and have found that what were formerly held to be separate and distinct forces [or, as people then preferred calling them, imponderable bodies, that is to say, substances which could not be weighed, and which had none of the other ordinary properties of matter], were in reality identical, and that one force passed into another kind of force, insensibly it might be, but not the less surely on that account.

To take an example: formerly men held electricity, magnetism, chemical force, heat, light, and motion to be things totally different and distinct. Now-a-days most men look upon these as one and the same, modified variously but still identical; so that either can take the

place of the other. As the simplest of these, motion has been accepted as a kind of starting-point, and hence all the various forces we have mentioned above, as well as certain others we might name, are held to be *modes of motion*. Everybody has heard of the plan adopted by some savage races to kindle their fires, when live embers are not to be had, and where lucifer matches are unknown. They rub together two pieces of dry wood until one or the other takes fire, and thus effect their purpose. Now, what have we here? We shall not yet speak of the changes within the body which movement implies, but, starting with the motion given to the two pieces of wood, we see how motion gives rise to heat, how heat ends in flame—that is, light-giving chemical change—and so on; for with chemical change begins a new series. Thus, when two metals of opposite characters are acted upon by compound substances, like oil of vitriol, or aqua fortis, or blue vitriol, chemical change goes on and electricity shows itself, as in the ordinary galvanic batteries, which are now familiarised to the public at the different telegraph stations. Electricity, in its turn, acting on a bar of soft iron, makes it a temporary magnet, which has the same powers for the time being as a loadstone. Electricity may also easily be converted into light and heat, as in the electric light which is now used as a beacon to sailors at Dungeness and other

lighthouses; in the better known and far more dangerous form of lightning; and in the sparks which may be drawn from the back of a cat by stroking her fur the wrong way on a frosty night. A more common illustration of motion converted into heat and light is seen when, by the friction of a long run, the axle of a railway carriage sets on fire the carriage to which it is attached. So much, then, for illustrations of the change of one kind of force into another. Now we must speak of those which take place within the human body.

In the human body, as in all other machines, every movement implies a chemical change; for wherever force, of whatever kind, makes itself apparent, there is change at the same time. As to the different kinds of change within the body, we do not now speak; we only deal with that implied in muscular motion.

What, indeed, we chiefly wish to do, is to illustrate the mechanics of the human body; to show, in other words, how much of the *machine* enters into its constitution and its various actions. For our purpose, no more apt comparison can be drawn than that which is afforded by the steam engine, to which, indeed, the human frame presents many analogies. In the first place, then, we may assume that the steam engine is composed of certain masses of iron, steel, and brass, arranged in certain definite forms, whilst the human

body, from our present point of view, may be assumed to be made up of certain bones, muscles, tendons, ligaments, blood-vessels, and nerves, also arranged in a definite fashion. And whereas the masses of metal composing the steam engine would be useless without the intervention of heat produced by some substance, such as coal or coke, and acting through the medium of steam produced by the action of heat on water, so the mechanism of the human body would be altogether useless without the food which we daily consume. Food stands in much the same relation to the human body as fuel does to the steam engine.

But the food of human beings is destined to fulfil other ends besides those implied by the fuel of the steam engine. The latter, after being constructed, daily wastes. Every day it becomes worse; for each stroke of its piston, to say nothing of the motion of its other parts, implies a waste of the piston itself, and of the cylinder in which it is enclosed, and in which it works. Now, when these get out of order, the whole machine has to be stopped, that the engineer may repair the deteriorated portions; but this is impossible in the animal frame without death ensuing. So that the human body is to be looked upon as an engine constantly working, constantly wasting, and constantly repairing its own deficiencies. But, just

as the coal which is used to drive the steam engine would be useless for the repair of the brass or iron of which the engine is composed, so would that kind of food which is most useful in supplying the means of motion in the human body be useless for repairing the waste of its tissues.

From this we are led to conceive that human food must consist of more than one kind of material, and so it does. If we take the staple of life as consisting of bread and meat, we find there the necessary substances: for bread, especially white bread, consists chiefly of starch, which may be likened to the coal of the steam engine; whilst meat consists of two portions, the fat and the lean, of which the former goes to aid the starch in propelling the machine, the latter going to repair the waste entailed by the action of the two former. Now how should we set about finding out how much work a steam engine had done in a given time? Not surely by estimating the infinitely small amount of refuse produced by the waste of the iron and brass, but rather by the amount of coal consumed. So in the human body, the work is to be measured by the starch and fat used up, or rather, by the products of these, not by the waste of the muscles [or of the meat in a changed form]. Nevertheless, this error was for a long time made in the case of man, and has only recently been exploded.

Now, as to the different kinds of motion observed in man or other animals, certain of these are common to all kinds of bodies, animal and vegetable, as well as mineral. Of such kinds are the motion implied by chemical change, by heat, and the more marked phenomena of gravitation; but, besides these, there are certain partly physical, partly vital phenomena, such as result from the commingling of oil and water, especially if the latter contain a substance like the white of egg. These movements were first observed by a well-known and distinguished botanist of this country, named Robert Brown, whence the movements are sometimes spoken of as the Brunonian, or, on account of the small size of the bodies concerned, molecular movements.

If we make the acquaintance of some of the lowest forms of animals and vegetables, we find ourselves on a kind of neutral ground, the inhabitants of which might belong to either kingdom, and to which of these they do really appertain it is not easy to say. Many of these lowly forms of animals and plants consist of a kind of jelly-like material, and apparently of nothing else. They have no organs of sense, no organs of digestion even, nor of circulation. Still these little structureless particles have the power of motion, and even of destroying beings much higher than themselves in the scale of animal life. From one of these living masses of jelly, called an

amœba, this kind of motion, by the protrusion of certain portions of the mass in any given direction, ultimately followed by the whole, has been termed *amœboid.* Still, this variety of motion, not depending upon gravitation, but on the vital action of the living being, necessitates chemical change, and consequently food. It is, indeed, seen even in man, in whose veins, and constituting a portion of his blood, flow certain small rounded and colourless bodies called white blood corpuscles, which frequently exhibit similar changes; often also particles of the same kind in other parts of the body do the same thing.

Mounting to a somewhat higher stage in animal life, we encounter a number of beings furnished with little fringe-like processes, which they can keep in constant motion. These fringe-like processes are termed *cilia,* and their motion is called *ciliary;* it may be used to illustrate a point to which we shall again have occasion to refer. The minute beings furnished with cilia are not unfrequently fixed to one spot, without the power of changing their place of abode. In these beings the cilia are useful for setting up currents in the water by which they are surrounded, by which currents particles of food may be driven to the creatures which are deprived of the means of going in search of it. But in others, which are free, the motion of their cilia in the surrounding water

resembles in its effects those of the screw of a steamer, for thereby the little beings are rapidly propelled from one point to another. Perfectly similar are the effects of a steamer's screw, which, the steamer being firmly fixed, would only be able to set up currents in the water but which, when the vessel is free from the shore, drives it rapidly along. This same kind of motion is also observed in certain parts of the human body, notably in the air passages, which are lined by these little bodies constantly waving about, and tending to drive any wandering particle which may have found its way into the lung back to the outer air.

Still, all these kinds of motion, as seen in the animal frame, sink into insignifigance when compared with that induced by the special apparatus prepared for the purpose, and which we term the muscles; that is to say, the red fleshy parts of an animal. It is with this kind of motion we have mostly to deal, and this apparatus we must carefully describe. There are, then, two kinds of muscles: one set more or less completely under the control of the will, the other more or less completely beyond this; the one kind is seen to most perfection in the powerful muscles of the arm and leg, the other in such an organ as the churning apparatus of the stomach. It is with the former we now must deal, and it will be enough, in giving an idea of its structure, to recall to

the recollection of every one how a piece of meat boiled for a long time tends to become stringy. These strings are the so-called muscular fibres, which are themselves, in turn, made up of smaller and finer threads.

Then, again, each muscle has a beginning and an end, or, as they are technically termed, an *origin* and an *insertion*. Most frequently both of these are connected with bones, the one end with one bone, the other with another; but sometimes this is not so, as in the case of the muscles which move the eyeball, one end of which is attached to bone, the other to the soft structures of the eye. But often the points to be connected are too far distant to be united altogether by muscular structure, and then, just as when a barge has to be dragged along by horses, a rope is used to transmit the power from the horse to the barge, so in the human body certain strong unyielding cords are employed to transmit it from the muscle to the bone; these we call *tendons*. Not unfrequently a muscle has a tendon of origin as well as a tendon of insertion; but it must be distinctly understood, that these are cords merely, which serve to transmit force from one point to another, and have nothing to do with the origin of the force, which depends on the shortening of the red muscular fibres, a property which is innate in them, and which is characteristic of them. When we examine all the muscles of the body (which

number upwards of 1,000), especially those of the limbs, we shall find that the one extremity of the majority is directed towards the centre of the body, the other towards the end of the limb, and it is the former which is most frequently termed the origin of the muscle.

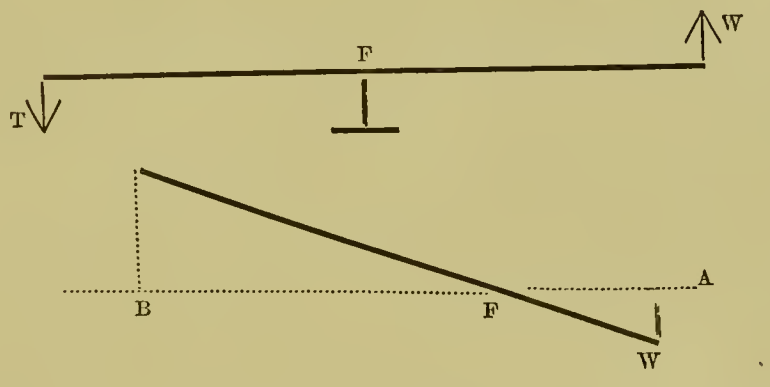
If now we trace a muscle and its tendon from its origin to its insertion, we shall most probably find that it passes over a spot where two bones come together. This we term a *joint*, the bones being united in two ways, either so that the one can move upon the other, or so that both are immovable. It is with the former class we have chiefly to deal; and for our purpose we may assume that these joints are of two kinds, either ball-and-socket joints, admitting movement in every direction, as in the case of the shoulder joint and hip joint, or hinge-like joints, such as those of the elbow and knee, where the motions are more limited in their character, and are almost restricted to one direction. For the construction of these joints two things are necessary—smooth surfaces of bone, rendered still more smooth by a layer of cartilage or gristle, the one surface corresponding to and fitting into the other, and strong bands or ligaments extending from the one bone to the other, so as to keep everything firmly in its place, and admit of only a limited degree of motion.

Having explained the machinery, so to speak, of the human engine; having shown it to consist of certain self-contracting muscles, the pistons as well as the boilers of the machine; of tendons, its connecting rods or belts; of joints, the grooves in which the rigid bones move and work; we must fall back on certain elementary principles in order to explain fully the working of this wonderful mechanism. In every solid body there is a point which is termed its *centre of gravity*, which being supported, the whole body will be so; and this in a solid corresponds to the point where certain lines cut each other. In the human body it will not be more to one side than another, and will correspond with a plumb-line dropped from the head when the individual is standing upright. So, again, it will be at those points in this line where the weights of the upper and of the lower half counter-balance each other. Finally, at the point where these two intersect each other, and encounter a third line corresponding with that in which the right side of the body balances the left, is the centre of gravity. In the human being this centre is situated low down between the two haunch bones, but it varies with every movement of the body.

Of all mechanical powers, again, the simplest are those known as levers, of which there are three

varieties. A lever consists of a rigid or unbending bar or rod, whereby a force is transmitted from one point to another, sometimes gaining power, sometimes losing it, as in the following examples. Lever No. 1

1.



consists of a rigid rod, movable upwards and downwards only, on a given point, which is called a *fulcrum*. At the one extremity of the rod a certain power is exerted, at the other is the weight to be raised, or the body to be influenced.

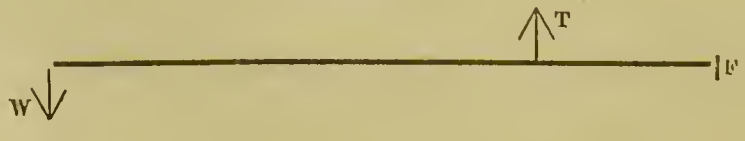
Now, when the fulcrum, F, is near the weight, W, the power, T, will have the advantage of the long arm of the lever; but, on the other hand, will have a longer distance, T B, to travel through before bringing W to a certain level, B A. On the other hand, were the fulcrum, F, nearer T than W, there would be a loss of power, but a gain in the distance to be travelled through; which, as it must be done in the same time by both arms, is technically known as a *loss of velocity*. On the other hand, were F equally

distant from T and W, both would be in exactly the same predicament; there would be neither gain nor loss in power or velocity, but the force would be transmitted unimpaired from T to W, and the velocity with which these would pass through a given distance would be the same. This is the condition in that useful example of a lever, the common balance for weighing sugar and tea and such like commodities, where the pound weight is the power, the knife-edge by which the balance is suspended is the fulcrum, and the substance weighed is the weight to be raised.

2.

In lever No. 2 we have the power at one end, the fulcrum at the other, and the weight between the two; so that it is evident that in this there must always be a gain of power, as the weight, being nearer F than T, will rest more upon that extremity of the lever, whilst there is a loss of velocity, T having to travel through a greater distance in a given time than W has.

3.



In lever No. 3 the very reverse is the case; for in this instance, the weight, W, is at one end, the fulcrum, F, being at the other, whilst the power, T, is between the two; so that, in this case, there is invariably loss of power and gain in velocity. As common illustrations of these forms of levers, we might take of No. 1, the act of stirring the fire with a poker; here the coals are the weight to be raised, the bars of the grate are the fulcrum, and the power is the hand applied to the end of the poker. So, of No. 2, a man pushing a wheelbarrow is a good example; here, the fulcrum consists of the wheel resting on the ground, the weight lies in the barrow, and the force is applied through the medium of the handles beyond it. Of the third form of lever we might take an example from a man in the act of dragging from the wall a ladder leaning against it; this he does by pulling one of the steps on a level with his shoulder (the power), and pushing his foot against the lowest step of the ladder (the fulcrum), and so raising the ladder (the weight) straight up in the air.

When we come to examine the human body, we find examples of all these forms of levers, although not in the same abundance. Thus of the first, where the fulcrum lies between the power and the weight,

we may take the common illustration of a man who has fallen asleep in his chair, when insensibly his head falls forward on his chest. Suddenly he awakes, and throws up his head, thus calling into play a lever of the kind described. For here, we have the head hanging forward as the weight, the fulcrum is the back-bone on which the head rests, whilst the power is the muscles fixed to the back of the head and to the back of the chest. The same kind of action is seen in a horse throwing up his head after drinking, and so on; but levers of this kind are not very numerous in the human body.

Lever No. 2 is exemplified in that kind of action which is implied by a man standing on tiptoe, for in this case the whole weight of the body, which ordinarily rests on the arch of the foot, is thrown forward, so as to rest on the toes, by means of the strong muscles in the calf of the leg contracting, and dragging up the heel. The toes are the fulcrum; the body resting on the arch of the foot is the weight; and the tendon of Achilles connecting the great muscles of the calf with the heel represents the power.

Neither is this kind of lever common in the human body, which, for the most part, chiefly affords illustrations of the *third* kind of lever, where the weight

is at one end, the power in the middle, and the fulcrum at the other end. To take a common example: in bending the forearm and hand on the arm, so as to bring the hand on a level with the shoulder, a strong muscle, called the *biceps*, is brought into play. This is the power, and it acts on the forearm just in front of the elbow joint, which is the fulcrum, whilst the hand and anything contained in it represent the weight to be raised. Now, the reason this kind of lever is so much more common in the human frame than any of the others is simple enough. There is, in the first place, the fact that it admits of much greater symmetry, but, from our present point of view, this is of no consequence; the second is, that, in the animal frame, the power which may be applied is practically unlimited, so that a gain of velocity is of much greater importance than a loss of power, for a muscle can easily be made large enough to insure strength as well as swiftness.

Still, in the human body, the means of employing force are identical with those seen in the steam engine, for there also, we have to deal with a series of levers. The up-and-down motion of the piston is communicated, by means of a crank, to a horizontal beam, which bears one or more toothed wheels, or some similar means of carrying power from one spot to

another. But these toothed wheels are only levers, where the axle is at once fulcrum and power, a combination which implies the greatest possible velocity with the greatest expenditure of power. The wheel which is driven by the one attached to this axle represents the weight.

When further we come to consider these mechanical forces as applied in the human body, we have to notice that, in very many instances, the tendon of a muscle is inserted obliquely into its bone; this implies an additional waste of force, for the nearer the perpendicular a force is brought to act on the lever, the greater is its effect. But, just as outside the body we find the direction of a force changed by means of a pulley, so we find the same thing accomplished in the body, when the tendon of a muscle is bound down by a sheath or a ligament, thereby effecting the change of direction with very little loss of power.

In all muscular actions taking place in the human being, the mechanical principles we have laid down are observed; but they are probably best illustrated by the various forms of progression, that is, moving from one place to another, employed by the human being. This leads us to consider another point in mechanics connected with what is known as the *base of support*, as applied to the centre of gravity. Every

one knows how much more difficult it is to keep upright a tall, thin body, than a broad and flat one; or, to take an extreme instance, to keep a spinning top upright on its point than on its head. This is because the base of support is narrow in the one case, broad in the other. In walking at sea a man strives to keep his feet apart, because the line from the centre of gravity naturally falls between his feet, and the farther they are apart the greater is his basis of support; and this habit gives to sailors their peculiar and, to landsmen, awkward-looking gait. There is an old saying, that cats always fall on their feet; the reason is, that the line from their centre of gravity falls downwards to the ground between their four limbs, and being extremely active they can always manage to keep it there. So babies, when beginning to move about, crawl before they walk, the centre of gravity being so much more easily kept within the base of support in the one case than in the other. As soon as the centre of gravity is disturbed, so that a line drawn from it, perpendicular to the surface of the earth, falls outside the base of support, a movement must be made, or the individual will fall down. This explains the old trick of asking a man to walk up to a wall, to place one foot close to it, and parallel with it, and then, asking him to raise the other, he

finds he cannot do so without falling, simply because his centre of gravity would fall without the narrow base of support afforded by the one foot.

Now let us consider the means by which a man may move from one place to another, thereby expending force in causing the contraction of certain muscles, these muscles acting on certain bony levers, whereby the body is moved. This leads us to consider the ordinary attitude of man in walking, the erect posture characteristic of the human race. The maintenance of this posture is not a merely passive act, for it requires the constant action of a certain number of muscles, which act in opposite ways, and so keep the human being upright. The first thing to be noted is the way in which the body is supported on the foot. The foot itself consists of an arch, the base of which is more extended in front than behind, and the whole weight of the body is made to fall on this arch by means of a variety of joints. These joints further enable the foot to be applied to rough and uneven surfaces, so that the flat portion of the foot may be adapted to these without inconvenience. The foot is connected with the leg by the ankle joint, before and behind which pass down tendons of muscles situated in the leg and directed to the toes, so that when both contract equally, the leg is held firmly on the foot

or the foot on the leg. The same arrangement is seen at the knee and at the hip; and in each instance we have a series of muscles on one side which may be made to antagonize those on the other, and those in front to oppose those behind: by the simultaneous action of all these muscles the limb is held fast, and the upright position is maintained. The one set of muscles, which keep the limb straight, are called *extensors*, those which bend the limbs are called *flexors*. It will thus be seen that the maintenance of the erect posture is by no means a passive effect, but the result of constant muscular contraction; so that when a man is stunned, or in any other way loses the command of his muscles, the first consequence is his tumbling down. The same names are applied to the muscles of the arm, but they are only called into play at intervals, and are not so constantly in action as the muscles of the lower extremities.

Connected with this subject is a venerable joke current among students of medicine, to the effect that, once on a time, a rude examiner asked a student who was being examined by him, "Now, sir, what muscles should I call into play were I to kick you down stairs?" To which the dutiful reply was, "The extensors and flexors of my arm, sir; for I should immediately knock you down." In this same action of kicking,

exactly the same muscles are called into play as in keeping the body upright, but they act in a different way. When a man stands erect, his foot planted firmly on the ground, any contraction of the muscles of the foot would only result in raising the body as on tip-toe; but should the limb be raised off the ground by bending the knee, then the muscles can act freely, and the foot can be moved in any direction: in the one case, the foot is the part most firmly fixed—in the other, the body is so.

Now, in walking, the first thing done is to throw the weight of the body on to one limb so as to free the other, which is then bent and flung forward until it reaches the ground; the centre of gravity advancing so as to fall between the two limbs, and beyond the original basis of support. When the foremost foot has been planted on the ground, the hinder one is found to be raised at the heel, so as to rest on the toes only, if the forward step has been a long one; but this is not the case in ordinary walking. The muscles are now powerfully called into play so as to act upon the leg and foot; but this being resisted by the toes planted against the ground, the opposite effect takes place, that is to say, the body, being more movable than the foot, is thrust forward. The hinder foot is carried with the body until advanced

to a level or in front of the other, the centre of gravity being at the same time carried forward with the body. Running is effected in the same way, but at a quicker rate, and the centre of gravity is generally kept quite in advance of the base of support; so that, if the feet are not moved quickly enough, or are interrupted in their progress, the individual is certain to fall.

It will thus be seen that the movements of the human body are effected in accordance with the same laws as regulate movement in the inanimate world. Of course we do not now speak of the intelligence displayed in these movements—that is a totally different thing; we only deal with the mechanics of motion as seen in, and illustrated by, the human body. In another chapter we shall speak of the adaptation of these principles to actual life in the practical forms of gymnastics and training.

X.

THE INFLUENCE OF OCCUPATION ON HEALTH.

In previous chapters we have explained the structure and function of various organs in health and in disease; it is now our intention to show that many of the diseases to which our bodies are subject, arise from simple and often easily remediable accidents of our daily life. A very close relation exists between health and occupation; and the more widely a knowledge of the principles of sanitary science is diffused, the more certainly will the health and happiness of our working population be secured. England cannot, indeed, hope to maintain her pre-eminence as a manufacturing country, unless the health and vigour of her artisans is preserved; and the prospects of the "working man" would be more surely advanced by improvements in his sanitary and social condition, than by an increase of his political power. It is always the feeble and unhealthy who are the most dissatisfied with their lot, and clamorous for the reform millennium; the healthy body and satisfied mind exist together, and a man who has health to enable him to overcome

obstacles and make his way in the world, is not likely to be very particular about the roughness of the road.

The influence of occupation on the health is not a subject for the consideration of a single class; for what overwork of body does for those who earn their daily bread in "the sweat of their brow," overstrain of mind effects for those who live by their brains. There have been many instances from the ranks of literature, science, and art, of men whose lives have been sacrificed by too intense devotion to their pursuits. Mendelssohn, who concentrated more brain-work within his short life than has sufficed for many whose years have extended to ten decades, died of paralysis at thirty-eight; his premature end most surely hastened by the perpetual unrest in which he spent his every day.

Our subject readily divides itself into two sections, viz., (*a*) influences general and indirect; (*b*) influences special and direct.

Amongst the former we refer to conditions of defective ventilation, overcrowding, long hours, etc.; and under the latter head we shall classify the injurious influences of particular trades.

The packing together of numbers of human beings in a confined room, tends at once to impair the purity

of the air; for its vivifying principle, oxygen, is replaced by that most injurious gas, carbonic acid. It is a primary natural law, that man needs an abundance of pure air to support his healthy existence.

> "A breath of unadult'rate air,
> The glimpse of a green pasture, how they cheer
> The citizen, and brace his languid frame!"

How imperfectly this requirement is supplied in large manufactories, and what a powerful source of mischief is at work in such places, may be indicated by the following facts. In 100,000 parts of pure air, there are rarely found more than 30 parts of carbonic acid: in rooms in towns, freely ventilated, the proportion rises to 80 parts in the same volume, while in ill-ventilated rooms and workshops there have been found from 100 to 700 parts, or twenty times nature's allowance. The working classes are exposed to no more fruitful cause of disease than this excess of carbonic acid in the air which surrounds them. When a high percentage of carbonic acid prevails, the circulation of the breathers is generally observed to become enfeebled, the frequency of respiration to increase, and nervous power to fail. Much of the consumption and scrofula of town populations is due to an atmosphere overcharged with this gas. Nothing affects its power for ill so much as an elevated temperature. "Thus even 1 per cent. of carbonic acid may be endured at

a temperature under 50° Fahrenheit, which at 70° or 80° would be absolutely intolerable." On entering a close room in which a number of persons have been employed for many hours, the atmosphere seems quite unbearable, and we gasp for an open window; while the workpeople, accustomed to the vitiated atmosphere, seem to breathe with ease, and say they do not feel any inconvenience. Is the closeness innocuous because it is not felt? By no means. Acclimatisation is dearly bought. By the gradual depression of all the functions, less oxygen is absorbed, and the vitiated air then suffices for an enfeebled organism, just as it would for the respiration of a cold-blooded animal. This kind of vital depression, when frequently experienced, is destructive to the elasticity and vigour of those exposed to it. In such an atmosphere, rapid and efficient work, to say nothing of comfort and happiness, is out of the question. It is gratifying to find from the last published reports of the Factory Inspectors, that very decided physical improvement has been effected by the factory regulation laws, and as a natural consequence "a wide-spread and almost universal improvement in tone both of the employer and employed has been noticed." Attention to the laws of health is thus seen to secure an immediate and permanent reward.

Long hours are not now, happily, so crying an evil as formerly, for the legislation of 1867 has placed reasonable limits on the time during which employers can keep their hands at work. There is even now, however, ample evidence of the prevalence of this evil, especially as it affects the young. In the east end of London, where it appears to be practically impossible to enforce the wholesome regulations of the Workshop Act, in consequence of the pauperism of the population, many hundreds of young children are employed from eight to ten hours a day in light handicrafts, such as the making of lucifer-match and other small boxes. Lord Shaftesbury's "Children's Employment Commission of 1861" brought to light many glaring instances of overworked children in the hosiery trades of Leicester and Derby, the straw-plaiting trade of Luton and Dunstable, the iron trades of South Staffordshire, and many others. It was invariably found that the most exacting taskmasters were the children's own parents, and recent experience in London confirms this fact. What wonder that the mortality should be excessive in districts where children have been kept hard at work in a temperature varying from 106° to 120° for six-and-thirty hours without going to bed, as in the glass works of Yorkshire, or where infants of but six years are pent up for fifteen hours

out of the twenty-four in small overcrowded rooms, as in the lace schools of Nottinghamshire? * Surely no more unfavourable conditions for the healthy development of mind and muscle could be imagined.

The restriction of the hours of labour in factories is not an unmixed good. In busy seasons, the necessity for rapid completion of orders is at times so great that home work is encouraged, and there performed perhaps in close rooms under even more unfavourable conditions than exist in the factory. It is not, of course, possible to carry about engines and machinery, but in many branches of trade "finishing work" may be done at home, and the limitation-of-time enactments are thus rendered worse than useless. In these "season trades," as they are termed, in which for several months in the year there is nothing to do, and then for a few months more than can be readily accomplished, it may perhaps be found that some slight modification of the law giving permission for a few extra work-hours per week during the summer months, may be found sufficient to meet their requirements. It is satisfactory to learn from the recent reports, that those employers who have acted up to the spirit of the "Workshop Regulation Act" have found that the

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* See Reports of above Commission.

increased energy and activity of the hands, when working under improved conditions in airy rooms, leads to the production of as much work in ten hours and a half as formerly required twelve or thirteen hours. In the presence of this fact, it is disappointing to read that the lace and straw-plait schools (being neither factories nor workshops) escape the operation of this Act, and many of the bonnet makers,* who consider themselves "young ladies," resist the interference of any law which classifies them with "factory workers."

Legislative enactments for the remedy of these evils exist already, which, if fully carried out, would accomplish much. A sufficient cubic space must be allowed to every factory hand, as it is to lunatics and paupers; and regard must be had no less to the quality than the quantity of the air supplied.

Plainly, to manufacture perfectly pure air by Act of Parliament and deliver it on the premises, is impossible: we must, therefore, do what we can to keep it wholesome, by devoting strict attention to ventilation, by the adoption of disinfectants for drains and sewers, so as to kill or render innocuous all organic impurities,

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* Although "there are no bonnets made now-a-days, straw may be worn in a thousand fascinating shapes," and the pressure put upon the producers is often temporarily so great as to lead to most distressing breaches of sanitary laws.—*R. Baker, Esq.*, "*Report on Factories*," *to Oct.*, 1868.

and by the preservation of open spaces in and near our great centres of industry. The ventilation of mines is under legislative regulation, and with the most beneficial results, many lives being thus saved annually. The ventilation of lodging-houses is also subjected to police supervision in the interests of their casual occupants. Surely the thousands who spend their lives in our workshops and manufactories have even a greater claim on the care of the State.

Much also might be done by the working classes themselves, by the cultivation of habits of personal cleanliness. The fact must not be disguised, that a most baneful consequence of overcrowding is the vitiation of the air by the emanations from the bodies of diseased or uncleansed persons. French scientific investigation has disclosed the unpleasant fact that skin dirt, composed of perspiration, oily matter, and dust, contains myriads of microscopic existences, both vegetable and animal. These cutaneous emanations are dissipated in and affect the air; add to these the pulmonary exhalations of consumptive and scrofulous persons, which are believed by some to be vehicles of contagion, and some idea may be formed of the risk to health incurred by those whose days are spent in an atmosphere so highly charged with organic impurities. "The greater the

aggregation of unwashed human masses, the more horrible must be the resulting atmospheric impurity." (Rumsey.)

In calculating the amount of evil arising from general causes, such as those now under consideration, the fact should not be overlooked, that although there may be no fatal disease, a condition of what has been called negative health is sure to be engendered, and the majority of the workers become debilitated, until life itself becomes a misery.

It is impossible to over-estimate the advantages which accrue to those who can mitigate the effects of the poison inhaled during the day by a residence where—

> "'Tis rural: trees are to be seen
> From every window, and the fields are green;"

and it should be a matter for general congratulation that the building of dwellings for the labouring classes in the suburbs, and cheap trains for their accommodation have brought this immense privilege within the reach of many who could not a few years ago have obtained it.

The working classes hold a remedy against long hours in their own hands;* but it is surprising to

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* We hope we may not be understood by this expression tacitly to advocate "strikes," for any such attempted remedy almost always proves a worse evil than the disease.

notice how slow they are to avail themselves of it. Indeed, they may be said in one respect to be consenting parties to the prevalence of this evil; for the adults are in most instances not slow to seize the opportunity of earning "overtime," and parents will go so far as to put pressure upon managers to employ children of tender years, and do not scruple to misstate the age of the little ones, so that they may not be brought within the clauses of the Factory Acts. Let operatives work more quickly while they are at work, that they may have time for rest or recreation after the day's work is over; for by means such as these they are more surely promoting their best interests than by falling in with the arbitrary regulations of trades' unions, as that, for instance, which enjoins that a man must only use one hand in laying a brick. The lower orders of the working classes might well take a lesson from the change which has passed over the habits of City men of business. A few years ago the ordinary working hours were from 8 a.m. to 8 p.m.; whereas now 10 to 5 is the rule; work which formerly occupied ten to twelve hours being now accomplished in half that time. But we can scarcely expect that any real improvement in the particulars we have mentioned will result until the elementary laws of health are taught in our schools, and the working population

have learned how much the maintenance of the sound mind in the sound body, "the only fund to which they must look for subsistence through life," depends on themselves. May we not hope that the English workman (instead of looking for assistance from the Legislature, or from benevolent societies) will determine to secure for himself those advantages which his own vigour and energy so well qualify him to attain?

The general or indirect influences which affect the health of the operative class, have hitherto engaged our attention. We will now refer to those directly attributable to certain callings. Such a large proportion of the ailments and diseases of this section of the population have an intimate relation to their occupation, that it is difficult to deal with the subject within the limits of a single chapter. As the enumeration of every trade to the pursuit of which special evil may be traced would probably prove tedious, we present in a tabular form on page 190, a few of the more prominent instances.

A few additional particulars in explanation of this summary may be of interest. The destructive influence of the steel-grinding trades of the Sheffield district was not generally known until the fork-grinders (who work on dry stones) drew up a description of the pernicious effects of their calling; in which they de-

clared that the average age of a fork-grinder did not exceed thirty years; that the men early contracted the "grinder's complaint," an asthmatic cough ending in consumption; that "life was a burden, and the frames of the poor sufferers wasted away, by a repetition of slow tortures." This was no over-statement of the case. A poet of their own town has graphically described the perils incident to this occupation, and, it must be added, has no less truly depicted the prevailing character of many of its victims.

> "There draws the grinder his laborious breath;
> There, coughing, at his deadly trade he bends;
> Born to die young, he fears not man nor death,
> Scorning the future, what he earns he spends: . . .
> Yet Abraham and Elliot * both, in vain,
> Bid science on his cheek prolong the bloom:
> He will not live! he seems in haste to gain
> The undisturbed asylum of the tomb,
> And, old at two-and-thirty, meet his doom!"

Flour, and more particularly dried "corn flour," is almost as injurious as metallic dust, affecting the constitution in much the same way. Bakers and millers are a short-lived class of men, seldom attaining more than forty years. "Shoddy grinders," boys employed in paper manufactories to sort, pick, and tear up old rags, suffer from a peculiar form of bronchitis caused

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* The inventors of the Grinder's Preservative, which the grinders will not use.

Occupation.	Average Hours.	Special Evil.	Remedial Suggestions.
Copper and zinc workers . . .	8 or 9	Inhalation of sulphuric acid, and coke fumes	Closed fireplaces, good flues, and thorough ventilation.
Knife and fork grinders, sand-paper makers, glass grinders, &c.	10	Lung disease from irritant effects of metallic particles inhaled	Magnetised wire, or other respirators.
Millers and bakers	10	Lung disease from inhalation of flour dust	Revolving fans and respirators.
Stonemasons	10	Lung disease from chips and dust of marble, stone, etc.	Natural respirators, viz., moustache; or artificial ditto, as gauze or handkerchief.
Cocoa-nut matting makers and weavers. "Shoddy grinders"	. . .	Bronchial affections from inhalation of dust	Gauze respirators.
Tailors and shoemakers . . .	12 to 20	Confined posture in close atmosphere	Adoption of sewing machines, change of position, and ventilated work-rooms.
Milliners	Uncertain	Close rooms, long hours, and night-work	Shorter hours, and airy working and sleeping rooms.
Sewing-machine hands	10	Stooping posture in close rooms	Ditto.
Warehousemen	8 to 10	Dusty and straining work, lifting heavy goods beyond strength	Care not to overtax physical powers.
Telegraph clerks	12	Close concentration of mind in confined atmosphere	Working in relays.

Occupation.	Average Hours.	Special Evil.	Remedial Suggestions.
Law stationers and commercial clerks	Very irregular	Compression of chest, producing malformation, and confining free action of heart and lungs, writers' cramp, or scribe palsy	A back to the high stool, light and flexible penholders.
Lucifer-match makers	. . .	Contact with phosphorus, producing jaw disease, "necrosis"	The use of amorphous phosphorus.
Artificial flower and green paper makers	. . .	Poisoning by arsenite of copper, causing loss of hair, loss of appetite, nausea, eruptions on the face, etc., etc.	The use of non-arsenical pigments.
Looking-glass silverers and barometer makers. "Water gilders"	. . .	Mercurial poisoning from absorption of mercury into the system	Careful washing, and the avoidance of direct contact with the mercury. Electro-gilding.
Printers and compositors . . .	16 to 18	Close atmosphere contaminated by constant gas-burning	Ventilation.
Type-founders, plumbers, and painters	10 to 12	Paralysis, wrist palsy, muscular wasting, caused by antimony and lead-poisoning	Machinery for mixing paints, frequent handwashing, especially before meals.
Engine-drivers and stokers . .	Irregular	Exposure to cold and wet, and heat of fire	Covered engines, as in Russia, America, etc.

by their dusty work, and chaffcutters and many others are similarly affected. The principal predisposing cause of the ailments of tailors and shoemakers is the adherence of these trades to the practice which demands that while at the "board" they shall squeeze themselves up into the most ridiculous of postures: which it is obvious must considerably curtail the space allotted to the free action of the vital organs. The adoption of the sewing machine is, however, taking much work out of the hands of the journeymen tailors, a girl being able in a week to attain as great proficiency in sewing or stitching as an apprentice would take two years to achieve with his unassisted needle.

The hard lot of milliners is well known. We mention their case only for the purpose of suggesting that the public who employ them might, by careful foresight, do more than the masters for the alleviation of their misfortunes.

Our readers will hardly have expected to find that sewing machines, so freely spoken of as the remedy for the grievances of overworked seamstresses, may be themselves classed among agents of mischief; but some machines work heavily with an up-and-down movement from the hip, which soon becomes extremely wearing; while others are set in motion by a light heel-and-

toe action, which may be long carried on without injury.

Our writing masters must be held responsible for much of the disease which attacks those who spend their lives at the desk, since children are taught to write with their bodies twisted into almost impossible contortions over their copy-books, instead of being allowed to sit in an easy, natural attitude. We can recommend those who have to write much, to adopt Lord Palmerston's plan of standing while they write, or else to sit on a chair with a back to it which may be drawn near the desk, and thus supply a rest for the back.

The arsenical compounds, mercury, lead, and antimony, the special bane of artificial flower makers, meteorological instrument makers, and of plumbers, painters, and printers, are subtle poisons which insinuate themselves into the system, and, as surely as they find an entrance, produce most disastrous results. Arsenic and mercury speedily induce a combination of disorders which end in an early death, whilst lead and antimony deal far less mercifully with their victims. It is the feature of lead-poisoning that all the natural functions are impeded; the removal of effete and injurious matters, which is continually taking place in a healthy person, is checked; and therefore the poison remains and accumulates in the system until circulation and respiration

become enfeebled, and death ensues. A painter, when discussing his midday meal, should realise that the lead in the paint on his hands is passing by little and little, *viâ* the bread and cheese, into his stomach, and may become the fruitful parent of many disorders.

A preparation of white lead (sugar of lead, as it is termed, from its sweet taste) has been largely used to whiten straw hats and bonnets. The dust is diffused through the air, and is inhaled and swallowed by the workpeople in such quantities as to be most injurious. Much illness has thus arisen, and several lives have been sacrificed. It has been suggested by a practical chemist, whose attention was drawn to the evil in question, that a paste composed of sulphate of baryta might be employed instead of the lead. This has been found to work well, and is quite innocuous. The white oxide of zinc will on trial be probably found equally fitted for the purpose. We would fain hope that we shall hear no more of lead-poisoning in the straw-plait trades.

These insidious foes are much more readily kept outside the walls, than ejected when they have succeeding in forcing an entrance into the citadel, and the workers in these metals should carefully adopt simple but effectual preventive measures. Too much attention cannot be given to frequent and thorough cleansing, and a

very Pharisaic dread of eating with hands unwashed would prove most wholesome.

One or two exceptional cases, which well illustrate our subject, have recently been brought under observation. A man suffering from lead-poisoning came to us, and in reply to our inquiry as to its cause, informed us that he was a clown, and had been using oxide of lead in order to give his complexion the particular hue required by the traditional usages of the stage. White zinc would not have been so dangerous, though probably equally effective. This incident may be a warning to others who seek to improve their appearance by the use of similar means, for clowns are not the only persons who resort to external applications for "beautifying" the complexion.

The men employed in riveting iron ships long suffered from the consequences of inhaling the noxious fumes from the furnaces used for heating the rivets within the ship's hold; fresh air could only be obtained through the hatchways, and the men died. At length a remedy was found; the rivets were heated on deck, and allowed to slide down pipes to the part of the ship where they were required. The products of combustion, so destructive in the above case, make the atmosphere of tunnels and of the Metropolitan Railway oppressive, and prove injurious to the men employed on the under-

ground line. This poison is most rife when, in a fit of misplaced economy, an attempt is made to burn impure and smoke-producing coke.

It will have been noticed that most of the occupations to which allusion has been made, have been such as are carried on indoors. The fact that those whose avocations expose them to the inclemencies of the wind and weather are far more healthy and long-lived than those who work under cover, is as remarkable as it is undoubted. When times of depression in trade occur, those whose business has kept them within doors cannot stand exposure to the elements, and are specially unfitted for emigration, however it may be called for by the terrible increase of our pauper population. To transport broken-down factory hands, and expect them to till the soil of our colonies, is plainly a mistake; but the scheme of taking their children to grow up in the open air where food is plentiful, instead of in crowded alleys where meat is at starvation prices, commends itself to all, provided that means are adopted for the proper care and protection of the youthful colonists.

In conclusion, let it ever be borne in mind that whatever may be the specific dangers attaching to particular occupations, there is no disease so deadly as no occupation at all; it is a rust that corrodes, and a canker

that corrupts all vital power both of body and mind. The absence of definite purpose in life, and of regulated effort to realise that purpose, is productive of the fatal distemper, of the languid stagnation of ennui, or of the distorted and morbid activities of hypochondriasis, rendering God's gift of life a burden or a torment.

It is never to be forgotten that labour is a law of our being; and even if there be some penalty involved in the difficulties and dangers attaching to labour, still it is at once man's glory and happiness to surmount and overcome them. Lord Stanley has feelingly and eloquently depicted the miseries affecting those who by their worldly position seem exempted and hold themselves exempt from the law of labour, and has commiserated those who consume much and produce nothing; production in proportion to power is the secret of a happy balancing of mind and body.

No one can take even a superficial view of the world in which we live, of the vast and ever unfolding secrets stored within its bosom, and of the marvellous faculties by which man is fitted to discover, develop, and apply those secrets, without feeling that well-regulated labour is happiness; that indolence is death; that "labour" is graven with a pen of inspiration over the field of the universe.

XI.

TRAINING AND GYMNASTICS.

We have dealt with the theory of motion as applied to the mechanism of the human body, and we have spoken of the application of our principles to one of the simplest forms or modes of animal motion, namely to walking. Nevertheless, although the power of changing its place is one of the great characteristics of an animal, in the case of the human being there are acts much more complex, and which require a more prolonged training than mere locomotion. Many of these movements involve the simultaneous or successive action of various groups of muscles, and each of these groups must be trained to take its appropriate portion of duty. Many of them also require great speed in their performance, others again great force, and sometimes both are necessary; but it may be safely assumed that if such be the case, *i.e.*, if both speed and force are necessary, the stage of training requisite for the due and proper performance of the action will become of necessity more important and more lengthy. Herein lies the difference between the labour of a skilled mechanic and a raw

apprentice. But, besides special training for special efforts, it is now-a-days well recognised that, for the human body to attain its greatest beauty and its greatest power, it is necessary to train not one set of muscles, or even several sets, but all in turn, and it is on this account that gymnastics have of late years received the attention they have, not only as a means of physical or bodily education, but also as a method of curing disease. Both of these subjects we shall consider in turn; but we shall first speak of the preparatory process, or that of training.

By all nations in a comparatively rude state of civilisation, feats of strength are highly esteemed; and among those which have attained a higher stage, strength when combined with skill is still valued and respected. Among the ancients, both Greeks and Romans, games of strength and skill were frequent, and even till lately boxing and prize-fighting were favourably received among ourselves. But then, as now, to a candidate for popular favour a prolonged stage of training was necessary before he could hope to attain to eminence; hence there arose a class of trainers for such exercises, as we have now-a-days at our universities in the form of grinders, men who train candidates for mental instead of bodily encounters. Gradually the plan adopted by these men

grew into a system, merely from experience, not from any scientific notions, and it is this system we have to examine.

If a man sets about any unusual exertion, say running a race, he will soon become painfully aware of the efforts required to keep up his circulation and his respiration; his heart will thump against his side, and his breath come thick and fast; whereas a man by his side may be going along as quietly and as easily as possible; but then he has been trained. We have shown how scientific mechanical principles may be brought to bear on human movements, how the muscles act on the bones as levers, how the muscles themselves may be likened to a steam engine. But to enable this engine to do its work, fuel is necessary, and this is supplied by the blood; if, therefore, the engine is called upon to move faster than usual, more fuel will be necessary, and the blood will require to be driven more rapidly through its textures. But as the blood soon becomes fouled with the products of its combustion, it requires renewing, and air must be admitted more rapidly into the lungs to carry off the foul gases produced. Hence increased muscular action implies a more rapid circulation of the blood and a more frequent breathing than are ordinarily required. This, then, is the scientific basis on which we have to proceed.

Trainers of the olden times supposed they had to contend against a fearful and concealed enemy which they called *inward fat;* and it was to dislodge this formidable antagonist, their efforts were chiefly directed. It was this, they said, which impeded respiration and circulation, which made a man puff and blow, and made his heart kick against his side. So far, no doubt, they were right; for fat will accumulate internally as well as outwardly, and especially the heart may so become affected, although this is not the dread foe to human life about which medical men talk; for there is another form of fatty heart, where the very texture of the muscle of the heart is turned into fat, and there is so little hope of training a man with such a heart to become an athlete, that the quieter he keeps himself the better for his life. Nevertheless, fat may accumulate, and so render the action of the heart less effective; but this is not the true explanation of the difficulty of breathing experienced by men suddenly called to unwonted exertions, for it occurs equally to fat men and to lean.

Every one is familiar with the fact that a man's bodily conformation materially depends on his employment; hence the strong sledge-hammer arm of the blacksmith, the horny hand of the shoemaker, and so of a variety of other occupations. For the human body is so constituted, that if any part is called upon for unusual

exertion, this exertion implies more rapid change of the blood in its parts, as well as a more liberal supply of that all-necessary fluid, which in its turn insures increased growth and bulk of the part. Thus, therefore, in a healthy individual increased exertion implies increased bulk and increased capacity for exertion. This is the basis of the training system, and the basis applies equally to external and internal organs. If any of a man's muscles be suddenly and unexpectedly called upon to perform some duty to which they are not accustomed, whether raising a heavy weight from the ground, throwing it from one spot to another, running or leaping—in short, any unwonted exertion—they will fail to perform it as satisfactorily as those which have been trained to their work. Further, the exertion will leave behind an uncomfortable soreness, which may last a day or two, indicating that the parts have been strained in performing this novel duty; but should the exertion be persevered in, the sense of soreness will become less and less till it entirely disappears; the exertion required to perform the act will also be less and less, for the muscles will be strengthened by each new exertion until finally they will perform their duty easily and satisfactorily.

But what applies to the outer parts of the body also applies to the more internal; for the heart, whereby the

blood is circulated, is a hollow muscle, and the principal forces whereby respiration is effected are also muscular. Now, a man's heart and his respiratory muscles may be good enough for ordinary purposes, he may have no difficulty of breathing nor any inconvenience of circulation, and yet if any extraordinary exertion is required, both heart and lungs may fail to do their duty in their usual quiet and imperceptible fashion. The cause of this will be readily intelligible from what we have already said—both the circulatory and the respiratory apparatus require training if they are to be called upon for any special efforts, just as with the more external muscles of the body.

A proper system of training must accordingly be one which provides for the due exercise of all the muscles, voluntary, respiratory, and circulatory; but it should also imply a diet best suited for the development of the muscles, that is, the formation of hard flesh, not of fat, for fat is not only useless, but injurious, from a trainer's point of view. Most of our readers will remember the general interest which was excited by Mr. Banting, when he published his pamphlet on corpulence. In this Mr. Banting pointed out the proper means to be adopted for getting rid of superfluous flesh, as it is euphoniously termed—in reality, of fat; he showed that a diet consisting almost entirely of meat, or of substances con-

taining little starch or fat, would, in course of time, reduce any one to the desired condition. This mode of procedure was enthusiastically adopted by a multitude of followers, some of whom indulged in it—if we may use the expression—or at all events carried it, so far as to make themselves seriously ill. Now, in the olden time something of the same system was adopted; men were fed on half-raw beef-steaks (biftecks sanglants, as the horrified French restaurateurs call them) with a small proportion of stale bread and certain vegetables. No beer or spirits of any kind were allowed. No doubt in the main this process was correct, for the meat would be the best thing to nourish the muscles, that is to say, to supply the waste of the engine; but it is not the best thing for fuel, for some other article of diet should be used as well as bread and meat, otherwise the system is sure to suffer.

Our readers may have seen the statement in the newspapers about the period of the University boat race, last year especially, that the Cambridge crew was trained *too fine*. This simply means that they had had too much work to do, and that their limited diet had told upon them, and made them weaker than they otherwise would have been. Many of these men while training suffer from boils, almost invariably an indication of a low state of bodily health, and not unfrequently more serious

results supervene. Navvies, again, are a class of men who work harder than most others, and their diet is often principally made up of bread, bacon, and beer; now this diet, although more liberal in several respects than that allowed by trainers, is still too limited; for not unfrequently these men suffer from scurvy almost identical in its character with that which afflicts seamen on long voyages when their ships are badly provisioned. It is further well known that a man cannot be kept in a high state of training for any length of time; he may be brought to perfection as far as muscular strength is concerned, but he cannot be kept there except his diet be altered; if not, he trains *too fine*. Now-a-days, however, trainers are becoming wiser. Mr. Maclaren, for instance, the well-known Oxford trainer, has published a work, which ought to be read by any one who sets about fitting himself for any great bodily exertion; he has pointed out the errors of the older systems, and shown that with the new better results may be attained. He boldly attacks the ancient beliefs as to inward fat and such-like superstitions, and founds his system on a strictly physiological groundwork. The first and most important consequence of this change in doctrine is a change of diet, which, under the new system, is much more liberal than of old.

Diet no doubt constitutes an important portion of any

system of training; by it alone, as we have seen, bodily changes of considerable importance may be effected, but by it alone we cannot develop our muscles, or give the frame unusual power and endurance. For this, exercise is necessary. As we have again and again said, increased action implies increased waste, but also more speedy growth as well as greater development, whence its value in a system of training. But exercise to do good should be systematised, and that now-a-days has been done, the system constituting what is called Gymnastics. We have said a *system*, for gymnastics, except undertaken systematically, are useless. Further, we have pointed out that gymnastics should be employed for two special objects; the one as a means of educating the body, the other for curing it in certain forms of disease. Then, again, according to the end in view, the character of the exercises should vary, and accordingly we have two systems to deal with, known respectively as *light* and *heavy* gymnastics.

Exercise, although the fact is too often overlooked, is really one of the necessaries of life. Man has been condemned to earn his bread by the sweat of his brow, but in return his labour has been blessed to him, for thereby his body is strengthened, his happiness increased, and his life prolonged. There are two great motives or inducements to exertion; these

are, the necessity for eating and the love of offspring, and of these two the former is undoubtedly the stronger; but, as bearing on our subject, it is interesting to note that where little or no exertion is necessary to procure sufficient food, just as where a supply large enough for ordinary wants cannot be obtained even with great exertion, the human race is of an inferior kind. It attains its maximum development where food is plentiful, but where it is necessary to work hard for it. Neither the negro, who can obtain a livelihood with scarcely any trouble, nor the Esquimaux, who can hardly procure one at all, can be compared in bodily or mental vigour with the European or the stalwart American settler.

But in many occupations under our system of civilised or divided labour, certain parts of the body are called into play to the exclusion of others; and it should be the special function of gymnastics to remedy this tendency to unequal development. No one who, especially in our large towns, has had occasion to examine the chests of a number of individuals—a process the necessity for which in our hospitals is painfully frequent—can have failed to be struck with the multitude of badly formed busts and undeveloped bodies which come before him. Now, for these, in many instances, a process of physical education would

be their salvation. Unfortunately it is not always to he had, for *skilled* masters in this department are much rarer than in those which relate to mental growth.

Then, again, with reference to another and perhaps a more interesting matter still, mammas constantly complain of the difficulty they have in getting their darlings to sit upright when they come to the age of fifteen or sixteen. Only the other day we were asked what should be done with a young lady who would not sit upright: our reply was unhesitating—"Let her have a course of light gymnastics." Some of our fair readers may remember their sufferings under the old system—not altogether, we are afraid, banished even now—of back-boards; and bearing in mind their hours of penance in them, they may desire to avert such troubles from their daughters: to these also we say, "Substitute gymnastics." Growth at the period of life of which we speak is remarkably rapid both in boys and girls; they shoot up and become tall and lanky, they want filling out, and are troubled with growing pains. Even men, when tall and thin, are seldom very erect, their muscles are too weak; and there is only one way of overcoming this weakness —by exercising them. Strengthen the muscles, and the drooping shoulders and semi-erect gait will disappear.

Muscles are intended for interrupted, not continuous action; give them intervals of rest, and they will go on acting, we had almost said for ever. But, it may be objected, there is the heart, which you have told us is really a hollow muscle; were it to cease to act, we should die. No doubt this is true in one sense: were it permanently to cease to act, undoubtedly we should die, but it is not continually contracting, it alternately contracts and expands, action and repose succeed each other even in the case of the heart, and still more should this be so with other muscles. To place a child upright against a straight board, or even on a music-stool, without any support, is not to give the muscles free play, but rather to confine their effect to a rigid and unyielding fixation of the body. Here it is all action and no repose for certain muscles, all repose and no action for others, and this is the very thing to be avoided; uniform development, the result of uniform exertion, is that at which we should aim.

One of the most serious features of life in the present age, is the rate at which men of action live in the great crowds which constitute our modern cities. The numerous inventions which have enabled us to vanquish time and space, have entailed on us the necessity of living fast, to use the word in its plain sense. He that would win the race of life must be at least as

speedy as his fellow competitors. So much depends now-a-days on education, both general and special, that parents are encouraged to force, as it were, the intellects of their children. A boy that is fond of his books is favoured over his rougher and hardier fellows, who prefer exercise in the open air to study: perhaps in our modern civilisation this is natural, but there can be no doubt that when carried to any great extent it is prejudicial. For a man to fight well the battle of life, nothing is more essential than a sound mind in a healthy body, but to insure a healthy body nothing is more needful than a due indulgence in the healthy sports of childhood, a due proportion of bodily, as contra-distinguished from mental, exertion in boyhood and manhood. The fine physique of our nation is no doubt to some extent due to our partiality for out-door sports, and doubtless also the effect reacts on the cause. All this only serves to illustrate our thesis, which is that education of the body is as necessary as education of the mind, and that the powers of the one should be cultivated alike with the powers of the other.

For all of these purposes gymnastics is the instrument we would employ; not gymnastics in the sense of such exploits as those of Blondin, Leotard, and the thousand-and-one nameless performers who

alternately delight and horrify their eye-witnesses—we cannot call them audiences—but gymnastics in the sense of a system of physical education. Now it is quite clear that the exercises which would be calculated to fit a strong and hardy man for the Oxford and Cambridge boat race, would be altogether unsuited for a gentle and tender girl who had a tendency to stoop. Hence it is good to speak of light and heavy gymnastics, the former adapted for the weaker class of learners, the other for those of stronger frames and more mature years. Further, we may classify gymnastic apparatus into movable and fixed; and we may deal with exercises specially intended to develop the upper parts of the body, and exercises specially intended to develop the lower limbs, as well as those which affect both.

As already pointed out, every judicious series of exercises will imply a training of the organs of respiration and circulation. Walking and running are those which perhaps most readily effect this, as they do not interfere with the upper limbs, and hence they are chiefly employed for improving "the wind" as it is called, for when the arms are brought into play for any powerful effort, say pulling at or lifting a heavy weight, if there be great resistance, the on-looker will speedily observe the performer become redder and

redder in the face, till he is almost purple. The reason of this is that, the muscles of his arms having proved insufficient to effect the removal of the body causing the resistance, he has called a new set of muscles into play by fixing his chest, so that during these powerful efforts no breath can be taken. Consequently, as the blood is rapidly undergoing change in the rigid and contracted muscles, and as the heart continues to drive the blood thus fouled through all parts of the body, it not being aërated by passing through the closed lung, the surface darkens, and the blood which should pass through the lung accumulates outside it, the two together producing the reddening and darkening of the features. This is straining the lung, not exercising it: it is equally injurious to both lungs and heart, for both are alike strained, the lungs to resist, the heart to drive on, the blood current. Hence, for gymnastics of the lungs and heart, exercises which do not involve the upper limbs should be selected.

It has been suggested that to exercise the lungs, that is to say to train them, the playing upon wind instruments might be usefully employed. Now, the playing upon such instruments as the flute and flageolet requires, comparatively speaking, little effort compared with that necessary in playing the more powerful brass instruments; and, provided the former be not used in

excess, would have, to say the least of it, no prejudicial effect on the lungs. This is not so with the others of which we have spoken. Only the other day, a bandsman came before us, pale and wasted. One would have supposed, to look at him, that he was consumptive. On examining his chest, however, it was soon found that it was not his lungs, but his heart, which was affected. He was suffering from one of the worst forms of heart disease, such as is generally induced by too great a strain on the organs of circulation, and which in his case led to speedy death. In this instance there could be absolutely no other cause traced than the nature of his employment.

The reason one set of instruments might be used in the way hinted at, and not another, may be readily explained. The essential part of the exercise in blowing wind instruments consists in a sudden and complete dilation of the lung with air, and its subsequent ejection, more or less forcibly and more or less gradually, the lung acting like the bag in the bagpipe. The complete distension of the lung is, as a rule, a good thing; but when great force is employed to empty it, when the escape of the air is resisted in any way, the proper and equable flow of the blood through the body, and especially through the lung, is prevented. Hence it is that in players on large brass instruments

the face is congested and red during their exertions; hence also results the injury to the heart, with sometimes, it may be added, destruction of certain portions of the lung. Thus, to exercise the lungs aright we should aim at their full distension, but at the same time at a free expulsion of the respired air; and there is no better method of insuring this than exercise on foot, walking or running as the case may be.

To one entering a modern gymnasium for the first time, the scene irresistibly appeals to his imagination as a representation of some mediæval place of torture. The spars, the ropes, and the restless figures swinging to and fro give the place a character quite peculiar to itself. Now, the exercises employed as a means of training in these establishments are mostly of two kinds; in one the body is the fixed point, in the other it is the movable portion of the apparatus. Certain also of the exercises are intended to develop the upper limbs, certain others the lower, but the former are the more numerous and important. It is further to be remarked that a great many of our sports and pastimes tend to develop one side or portion of the body more than another, a thing which should, if possible, be avoided, equable development being most desirable. Thus football favours the growth of the lower limbs; cricket, the lower limbs and right arm;

rowing, the lower limbs, loins, and arms; racquets, tennis, etc., chiefly the lower limbs; fencing, the lower limbs and right arm; walking, running, leaping, etc., the lower limbs only. To counteract the influence of these, or perhaps, more exactly, to correct it, is the function of the teacher of gymnastics; and it is for this reason, perhaps, that most gymnastic exercises tell largely on the arms.

We have already pointed out that movement is the great thing in all exercises. To overcome resistance as well as to secure motion, no doubt, implies the expenditure of more force; but mere movement is in many cases a gain real and decided. Athletes will boast of the size of their biceps (the large muscle which stands prominently out when the arm is bent at the elbow, so as to bring the fist to the shoulder), and of the weight of the dumb-bells they can use; but the wise man will think less of these things than of the fact that his muscles are getting that exercise which is essential to their well-being and to his healthy condition. What we chiefly insist on is, that motion is of more importance than is violent exercise, and hence that light apparatus may be quite as efficacious as heavier implements.

An American, called Dio Lewis, has issued a work and a series of apparatus which will be found useful

in the physical training of boys, girls, or invalids. The apparatus is contained in a small box, and consists of a pair of light wooden dumb-bells, a pair of very light Indian clubs, a long wooden rod, and a pair of wooden rings, the last for combined exercises. In Mr. Maclaren's system, dumb-bells are alone recognised, all the more difficult exercises being accomplished by means of fixed apparatus. What are called gymnasiums are sometimes advertised in the papers: these usually consist of a number of cords, composed of India-rubber, which the individual desirous of exercising himself is supposed to pull out, the elasticity of the rubber causing the recoil. This is all very well; but the apparatus is expensive, and, it must be added, unsatisfactory, except for exercising certain definite groups of muscles under the direction of a surgeon. Nothing more is wanted than what we have mentioned (light dumb-bells, light Indian clubs, and a rod); and, indeed, it may be said that the motion of the body itself, without any extra artificial resistance like that afforded by dumb-bells, Indian clubs, and such like, is quite sufficient for the purposes of physical education.

There is with few exceptions a tendency for the right side to attain a superiority over the left. It is advisable in certain respects to counteract this tendency. Hence exercises in physical education should

take cognisance of one side as well as of the other. There are, however, certain cases where this should not be so; but these come more under the notice of the medical man. They are cases of deformity or partial paralysis.

Many kinds of mal-development are best treated by gymnastics. Take for instance what is called the *pigeon breast.* In this the breast-bone of the individual projects far forwards and forms a ridge like that of a fowl; his ribs are flattened and too straight, running almost directly backwards. The chest, which contains the lungs and heart, is therefore too narrow from side to side, too wide from back to front; but the latter does not compensate for the former. Such individuals are always unhealthy. They are liable to coughs and colds, and very frequently are consumptive. Had they when young, before the bones were too firmly set and knit together, been put through a regular series of exercises which would tend to expand the chest, this would have been avoided, and the individuals might have been strong and healthy. In no case is it too late to do something, provided only the exercises be judicious; for this, after all, is the main point. They should be regularly graduated, becoming more and more active till something of the desired result has been attained.

Others, again, suffer from a peculiarity the very reverse of that just alluded to; their breast-bones, instead of projecting or bulging, retreat and form a hollow at their lower portions. This condition is frequently observed in shoe-makers who have taken to their trade early in life, and whose health has not been satisfactory. Many of these operatives work with the boot or shoe constantly pressing on the lower part of the breast-bone, so that if the bone is soft, as it is in certain forms of disease, or indeed we might say as it is in all unhealthly conditions early in life, a permanent indentation is the result. In such conditions also gymnastics is the appropriate remedy.

Nor does the application of exercise to medicine cease here. Ling, an enthusiastic Swede, conceived that gymnastics might be much more widely used than they even now are in the treatment of diseased conditions, especially of deformities. He was, in course of time, able to erect a building devoted to this purpose, and even now this institution and many others on the Continent are engaged in the work of healing.

There is no deformity more painful to the sufferer or to the beholder than a crooked spine. But of this there are two kinds. In one the bones are thrust abruptly backwards, so as to form a projecting angle; and, as this generally depends on disease of the bone,

little is to be done for it. In the other the spine is curved, but not angular, and the curve is to one side, not backwards. One shoulder is higher than the other, and the sufferer has what is called a hunch-back. This may also to some extent depend on diseased bone, but it is certainly favoured by weak muscles. Exercise, therefore, which will tend at once to straighten the spine and to strengthen its supporting muscles, should be encouraged; that is, if there is nothing to indicate thas its employment might cause mischief. Thus, were the bones in a state of actual and active disease, rest should be urged; but if there is nothing more than a mere softness of their texture, exercise is the best remedial measure possible. It has been too much the practice to bolster up such unfortunates in iron cases of all kinds, what are called spinal supports among the number, and in certain conditions these are, no doubt, requisite; but we strongly insist on the fact that in particular instances they are as injurious as exercise would be in others.

Let us take another illustration. Painters, who have much to do with white lead, are extremely liable, after a time, to what is called lead-poisoning. The lead by degrees gets into their system, and gradually their health deteriorates. They become subject to colicky pains, their bowels are confined, and finally, if

they have not taken warning, they have "dropped wrist." The dropped wrist depends on a partial paralysis, a palsy which affects certain muscles, and certain muscles only. The patient may be unable to lift up his hand, so that the back of it shall be turned upwards; yet he may have perfect power to close his fist and to grasp any body with nearly his usual force. In short, the extensor muscles of his hand are paralysed. The same thing, or something similar to it, may occur to other muscles without evidence of any kind of poisoning, so that we may consider the two kinds of paralysis together, putting aside for a moment the treatment that should be adopted to expel the lead from the system.

As a rule, wherever there is partial paralysis, exercise is the thing to do good. But how, it will be said, is it possible to exercise a paralysed muscle, one over which you have no control, no power to make it do as you like? So it may be; still exercise is what is wanted, and it is obtained by means of electricity or galvanism. A galvanic battery, or a magneto-electric machine which you turn with your hand, is employed. The patient's affected hand grasps one of the holders, or, as they are technically called, poles of the battery. The physician applies the other to the affected muscles. If these be very bad, there

may be no response to the applied agency, but generally contraction is prompt, and not unfrequently painful. The process is repeated again and again. In other words, the muscle is exercised. Its contraction implies waste, change in its textures, renewal, and growth. The only difference has been that, whereas in ordinary muscular action the nerve stimulus is enough, we have here to apply a galvanic battery to insure the contraction of the muscle; but the result is the same, and in both instances it is beneficial.

We might give other illustrations of the same rule, that growth and health are everywhere dependent on exercise, natural or artificial; but we have said enough to establish our thesis, and, we trust, to attract more general attention to an all-important matter. We are no advocates of violent exertion of any kind, for this, as we have shown, is only too fatal to heart and lungs; but we would strongly urge on parents, especially on those whose children are somewhat weakly, the necessity of physical education. Children who have no desire for the sports of their time of life ought not to be encouraged in their sedentary habits without some counterbalancing means of exercise. It is not good to heavily task either mind or body before they be properly developed. Children should not be tired out either with lessons or with gymnastics, but they should have

something of both. Finally, we have shown how exercise, natural or artificial, may be employed in the art of healing for the relief of weakness or even of actual suffering.

The whole subject is so extensive that we have only been able to give a brief outline of it; but we repeat that systematic exercise is an all-important and too much neglected means of maintaining health and of remedying disease.

APPENDIX.

The following is an abstract of Professor Ferrier's recent experiments upon the functions of the brain, by means of electricity, abbreviated from a report published by him in the "Journal for Anatomy and Physiology."

The first experiments recorded have special reference to the production of epileptic convulsions; and the mode in which the attacks begin and the march of the convulsive spasms are accurately recorded. All the animals were under the influence of chloroform.

It is found that in rabbits, cats, and dogs, the application of the electrodes for a few seconds induced almost immediately, or, on some occasions, after the lapse of a distinct interval, violent epileptic convulsions of one side. When the electrodes were applied, one at the anterior and the other at the posterior part of the hemisphere, the convulsions were complete and violent in the whole of the opposite side of the body. As a rule, they commenced in the face, spread to the neck and upper extremity, and then invaded the hind-leg and tail. Dilation of the pupil, spasms of the jaws, foaming at the mouth, and loss of consciousness, were induced when the fits were at their greatest intensity.

Occasionally the spasmodic convulsions remained localised in one or other limb, or in some one muscle or group of muscles, and frequently, instead of an epileptic attack, a series of twitches alone were manifested.

The paper contains the chief results of a research commenced with a view to test the accuracy of the views entertained by Dr. Hughlings Jackson on epilepsy and St. Vitus' dance. Dr. Jackson regards convulsions affecting one side only as dependent on lesions of the convolutions of a certain part of the brain. In order to put this theory to the proof, the author determined to expose the brain in various animals, and apply irritation to the surface.

The method of irritation was suggested by the experiments of Tritsch and Hitzig, who had shown that contractions of definite groups of muscles could be caused in dogs by passing galvanic currents through certain portions of the anterior regions of the brain.

The progress of the research ultimately led to the endeavour to establish the localisation of cerebral function, not merely as regards motion, but also as regards sensation and the other faculties of the mind.

The method of experimentation which the author has adopted is to place the animal under chloroform, and gradually expose the surface of the brain, by removal of the skull. In this way he has been able to expose the

whole hemisphere. After removal of the membranous coat, the points of blunted electrodes in connection with a Du Bois Raymond's coil are applied to the surface of the brain, without injury to the outer grey substance.

The march of the spasms is shown to be quite in accordance with the bedside observations of Dr. Hughlings Jackson in cases of epilepsy of one side in man. Peculiar variations in the mode in which the attacks commenced, depending apparently on the position of the electrodes on the surface of the brain, led the author to approximate the electrodes, and to apply very limited irritation, in order to discover whether the convulsive spasms were not due to over-violent irritation of localized centres in the brain, whose special function is to govern and direct the action of these muscles for definite purposes, possibly such as might indicate volition and intelligence.

The results were such as to indicate, with a beautiful degree of exactness, the localization in certain definite and easily-defined regions, the cerebral centres for various apparently purposive combined movements of the muscles of the limbs, as well as of the tail, the facial muscles, and the muscles of the jaws and tongue. These are all situated in the anterior parts of the brain, and the individual centres are marked off in the various external convolutions.

The general plan is, that in the superior external con-

volutions, the various movements of the paws, legs, and tail, are centralized; and it is shown that the distinctness of these centres is, to a great extent, characteristic of the animal's habits; the centre for the fore-paw in cats being much more highly differentiated than in dogs and rabbits.

The middle external convolutions direct movements of the eye-lids, face, and eyes; while the inferior govern various movements of the whiskers, angles of the mouth, depressors of the lower jaw, and tongue.

From other convolutions, when irritated, certain movements are described as resulting, viz., of the ears, eyes, etc. In the paper as yet published, no attempt is made to explain the signification of these; but the author stated at the meeting of the British Association, that, from his later experiments, he had been able to obtain indications of the situation in these regions of the centres of special sense, sight, hearing, and smell. These results and conclusions are, however, not as yet detailed fully. The author indicates, in a note in the paper published in the West Riding Reports, that he had at that time explored the brain of the monkey, and satisfactorily localized the regions and centres corresponding to those already discovered in the brain of the cat, rabbit, and dog.

One of the more important conclusions drawn from the experiments is, that the region which governs the move-

ments of the mouth and tongue in cats and dogs corresponds to that which is known as Broca's convolution in man, and which governs the power of speech: viz., the posterior part of the inferior frontal. This, it may be stated, is further borne out by experiments on monkeys.

The pathology of aphasia, or speechlessness, is thus rendered comparatively simple. The memory of words is situated in that part of the brain which governs the movements of articulation. It is shown, however, by the experiments, that the brain is symmetrical, and that the corresponding part of each hemisphere produces exactly the same effects on opposite sides of the body. Generally the action is on one side only, and that the opposite one; but as regards the mouth, the action is almost bilateral, and hence disease of one or other side alone does not cause paralysis of the articulating muscles, because the other side is able to govern as before. The occurrence of loss of speech with lesion of the left side, is attributed to the fact that most people are left brained; and that, therefore, a lesion of the left side causes such an interference with the voluntary recalling of words, that the person is speechless, not because memory of words is utterly lost, as this exists in the undamaged side, but because he is unable to lay hold of the word he wishes to express. With the education of the other side, however, the individual recovers the power of speech. During the interval

of recovery of speech, only automatic expressions, or interjections, are uttered, which are evoked by a sort of reflex action, and unconnected with volition.

The cerebellum is shown to have a function which has never been allotted to it, viz., to be the co-ordinated centre for the muscles of the eyeballs. The author has only given the results of his experiments on the cerebellum of rabbits; but he has since extended and confirmed them in cats, dogs, and monkeys.

The various lobules of the rabbit's cerebellum are shown to have the power of directing the eyes in certain definite directions—an action which is intimately connected with the maintenance of the general balance of the body.

INDEX.

A.

Absinthe, ii. 155.
Absorption, i. 203.
Abstinence, Total, ii. 126.
Accidents, i. 238.
Acne, i. 206.
Addison's Disease, i. 190.
Adjustment of Eye, i. 80.
Affinities, i. 188.
Aids to Digestion, i. 176.
Air, i. 245, 257, 266; ii. 100.
  Cells, i. 252.
  Impure, i. 263.
Albino, i. 189.
Alcoholism, ii. 125–155.
  Cause of Dropsy, i. 168.
Amaurosis, i. 98.
Amœba, ii. 162.
Animal Heat, ii. 15, 18.
Animals, Lower, ii. 161.
Ant-eater, i. 129.
Anxiety, Effect on Digestion, i. 174.
  Relief from, i. 28.
Aphasia, ii. 227.
Apoplexy, ii. 58.
Apparatus for Analysing Breath, i. 258.
Arrowroot, i. 159.
Arteries, i. 285.
Assimilation, ii. 191.
Atmosphere, ii. 23.
Attention, i. 17.

B.

Backbone, ii. 170.
Bacon, i. 119.
Baldness, i. 200.
Banks, Mr., ii. 77.
Barracks, i. 267.
Bath, i. 207, 224.
Bathing Injurious to the Ear, i. 55.
Bed Sores, i. 229.
Beer, ii. 148.
Belladonna, i. 70.
Beneficence of Pain, i. 228.
Biceps, ii. 171.
Bile, i. 113.
Biliousness, i. 122.
Black Draught, i. 123.
Blindness, i. 62, 216.
Blisters, i. 184, 236.
Blood Poisoning, ii. 153.
  In the Lungs, i. 255.
  Vessels, ii. 131.
Blood-shot eye, i. 75.
Blue Pill, i. 123.

Blushing, i. 9, 232.
Body, Whole, i. 47, 53.
Boxing Ears, i. 49.
Brain, i. 1; ii. 226, 135.
  Cells, i. 19.
  Convolutions of, i. 14.
Breathing, i. 249, 256.
Brown, Robert, ii. 161.

C.

Canal Alimentary, i. 152.
Canals, Semicircular, i. 35.
Capillaries, i. 255.
Carbonic Acid, i. 261, 249; ii. 95–104, 127–138, 178.
Cartilage, ii. 165.
Cataract, i. 96.
Cast of the Eye, i. 76.
Centre of Gravity, ii. 166.
Cerebellum, ii. 228.
Cerebrum, i. 17.
Chameleon, i. 128.
Cheese, i. 140.
Chemical Change, ii. 162.
Chest, i. 225.
Chimneys, i. 266.
Chloroform, i. 236.
Choke Damp, i. 249.
Cholera, ii. 10, 29.
Churning in the Stomach, . 163.
Cilia, i. 107, 112; ii. 162.
Circulation, i. 199.
Climate, ii. 153.
Cleanliness, i. 209; ii. 183, 192.
  Of the Ears, i. 56.
Cochlea, i. 36, 47.
Coincidences, ii. 62.
Cold, Effect of on Taste, i. 138.
  Bath, i. 210, 214.
  In Intoxication, ii. 147.
  Feet, ii. 51.
Colds, i. 107.
  Deafness after, i. 43, 52.
Coma, ii. 145.
Combustion, i. 263.
Concealment prejudicial, i. 31.
Conjunctiva, i. 74.
Connective Tissue, i. 178.
Consciousness, ii. 59.
Consumption in Army, i. 268.
Convolutions, i. 21; ii. 226.
Cookery, i. 139.
Corium, i. 182.
Cornea, ii. 48.
Corpulence, a Disease, i. 180.
  Cure for, i. 182.
Corpuscles of Blood, ii. 162.
Coughing, ii. 13.
Creator, i. 49, 238, 242.
Cricket, Note of, i. 48.
Cuticle, i. 178.

D.

Damp Beds, ii. 15, 23.
Deafness from colds, i. 43, 47, 51; ii. 12.
Death in Coma, ii. 147.
Deceptions in Disease, i. 220.
Desquamation, i. 186.
Determination of Blood, ii. 49.
Development, mental and physical, i. 23; ii. 206.

Dialysis, i. 138.
Diaphragm, i. 255.
Diet, ii. 204.
Dietetics, i. 142.
Digestion, i. 122.
Dirt in the Eye, i. 64.
Distant Objects, i. 85.
Diving Bells, i. 41.
Dram Drinking, ii. 150.
Draughts, ii. 22.
Dreaming, ii. 63.
Dreams of the Whale, ii. 59.
Drinking, ii. 152.
  On empty Stomach, i. 117.
Dropsy, i. 118.
Drum of the Ear, i. 41.
Dyspepsia, i. 240.

E.

Ear, i. 33.
  Nerve of, i. 46.
  Stones, i. 34.
  Wax, i. 38.
Early Rising, ii. 75.
Eau de Cologne, ii. 150.
Echo, i. 59.
Electricity, ii. 157.
Electrodes, ii. 255.
Emigration, ii. 174.
Emotion, Influence on the Body, i. 30, 227.
Ennui, ii. 150.
Epidemics, ii. 30–33.
Epidermis, i. 178.
Eruptions, ii. 8.
Eustachian Tube, i. 40, 41.
Evaporation, ii. 18.
Excess of Food, ii. 152.
Exercise, i. 187, 211; ii. 205.
  Beneficial to Nerve-distress, i. 31.
Exertion, ii. 154.
  Mental and Physical Opposed, i. 27.
Exhilaration, ii. 135.
Eye and Sight, i. 59–101.
  Jaundiced, i. 120.
Eyeball, i. 89; ii. 135, 164.
Eyelids, i. 63.

F.

Factory Acts, ii. 185.
Fat, i. 181; ii. 134.
Fatigue, i. 26; ii. 135, 148.
  In looking at small Objects, i. 86.
Fatty Heart, ii. 200.
Fear, Effects of, i. 203.
Feats of Strength, ii. 198.
Fermentation, ii. 127.
Ferrier, Prof., Experiments of, ii. 223.
Fever, ii. 126.
Fishes breathe Air, i. 250.
Flame, i. 224.
Flour, ii. 187.
Focus of the Eye, i. 79.
Food, i. 156; ii. 85, 143.
  a Fuel, ii. 159.
  a Stimulant, ii. 152.
Force, ii. 156.
Freckles, i. 191.
Fresh Air, Effect on Brain, i. 28.

Frog, i. 128.
Fulcrum, i. 128.
Fur on the Tongue, i. 144.
Fusel Oil, ii. 128, 154.

G.

Gall Bladder, i. 113; ii. 113, 114, 118.
Stones, i. 118.
Galvanism, Origin of, i. 137.
Ganglia of Brain, i. 16.
Gas vitiates Air, i. 266.
Gastric Juice, i. 154.
Germany, Short Sight in, i. 94.
Giddiness, ii. 145.
Gin-drinker's Liver, i. 147.
Glands, i. 65.
Gluten, i. 169.
Goose Skin, i. 184; ii. 2.
Gout, i. 231.
Grits in the Eye, ii. 64.
Gymnastics, ii. 205.

H.

Habit, i. 21; ii. 72, 81.
Hairs, i. 182.
Sacs, i. 194.
Destruction of, i. 196.
White in Old Age, and from Shock, i. 197.
Hay Fever, ii. 11.
Head Dress, i. 53.
Headache, ii. 38, 52.
Health, ii. 176–196.
And Happiness, ii. 176.
Heart, i. 255; ii. 201.
Affected by Pain, i. 235.
By Alcohol, ii. 135.
Heat and Cold, i. 219; ii. 158.
Effect of, on Liver, i. 115.
Hicks, Dr., i. 113.
High Notes inaudible, i. 48.
Hippocrates, ii. 9, 29, 50.
Huss, Magnus, ii. 153.
Huxley, i. 103.
Hydatid Tumour, i. 120.

I.

Iceland, i. 121.
Idleness deleterious, i. 25; ii. 195.
Imaginary Pain, i. 227.
Imponderable Bodies, ii. 157.
Impurity in Spirits, ii. 154.
Inattention, Deafness a Cause of, i. 51.
Incus, i. 44.
India, Effect of on Liver, i. 115.
Indigestion, ii. 35, 42, 71.
Cause of Headache, i. 214.
Infant Bathing, i. 214.
Inflammation, i. 232.
Influence of Occupation on Health, ii. 178.
Influenza, ii. 9, 10, 26–39.
Insects, Smell in, ii. 113.
In the Ear, i. 54.
Insertion of Muscles, ii. 164.
Inspiration, i. 256.
Intemperance, Effect on Liver, etc., ii. 116.
Interaction of Body and Mind, i. 24.

Intoxication, ii. 138, 146.
Involuntary Actions, 11.
Iris, i. 69.

J.

Jackson, Dr. Hughlings, ii. 224.
Jaundice, i. 119.
Jelly-like Animals, ii. 161.
Joints, ii. 166.

L.

Labourers, ii. 51.
Labyrinth, i. 36.
Lacteals, ii. 131.
Lassitude, ii. 7.
Late Dinner, ii. 151.
Legislation, Sanitary, ii. 182.
Length of Tubes in the Skin, i. 202.
Lens of the Eye, i. 81.
Levers, ii. 166, 170.
Liebig, ii. 134.
Life of the Brain, i. 28.
  Four Kinds of, i. 20.
Ligaments, ii. 165.
Light, i. 223.
  Rays of, i. 84.
Liver and its Diseases, ii. 113–124.
  Gin-drinker's, ii. 132.
Living Tissues under Alcohol, ii. 130.
Livingstone, i. 237.
Locality of Sense of Taste, i. 137.
  Of Pain, i. 233.
Long Hours, ii. 180.
Longevity, i. 187.
Loose Clothing, ii. 19.
Lungs, i. 253; ii. 12, 133.

M.

Machinery of the Body, ii. 136, 158, 166.
Maclaren, Trainer, ii. 204.
Magnet, ii. 107.
Mastication, i. 154, 170.
Meals replaced by Drinking, ii. 151.
Meatus of Ear, i. 44.
Medicine, ii. 152.
Medulla Oblongata, i. 196.
Membrane, Breathing, i. 249, 254.
  Of the Nose, i. 106.
Membranes, Effect of Alcohol on, i. 129.
  Of the Ear, i. 73.
Memory, Connection of Smell with, i. 115.
Mental Life, Relation to Animal, i. 13.
  Dependent on Convolutions, i. 15.
Midriff, i. 255.
Milliners, Occupation of, ii. 190.
Motion, ii. 157, 163, 197.
  Modes of, ii. 107.
  Nerves of, i. 9, 16.
Mouth, Food in the, i. 160.
Mucous Membrane, i. 177; ii. 2, 311.
Muscles, ii. 163, 174, 175, 202.
  Of the Ear, i. 44.
  Of the Eyeball, i. 77.
  Of the Foot and Leg, ii. 176.
  Of Voluntary Motion, ii. 156, 175.
Music, Appreciation of, i. 47.
Myopia, i. 91.

N.

Nails, i. 191.
Narcotics, i. 236.
Navvies, ii. 204.
Negro, Skin of, i. 189.
  Pied, i. 190.
Nerves, ii. 43, 69, 85, 140, 144.
  Anatomy of, i. 6.
  Influence of on Muscles, i. 10.
  Influence of on Vessels, i. 5.
  Of the Ear, i. 44, 59.
  Of the Eye, i. 72.
  Of Smell, i. 4, 107, 112.
  Of Taste, i. 127.
Nervous Force, Origin of, i. 3.
  Headache, ii. 51.
Neuralgia, i. 231.
Night Air, ii. 21, 22.
Nightmare, ii. 69.
Nitrogen, i. 247.
Nose Bleeding, i. 126.

O.

Odorous Bodies, i. 123.
Oil of Wine, ii. 127.
Olfactory Nerve, i. 106.
Ophthalmoscope, i. 99.
Opiates, i. 236.
Origin of Muscles, ii. 164.
Ossicles of Ear, i. 40.
Oxygen, ii. 94, 98.

P.

Pain, Function of, i. 262.
Palsy, ii. 145.
Papillæ, i. 131, 218.
Paralysis, i. 239.
Parasites, ii. 120.
  In Oil Glands, i. 205.
Paté de Foie gras, i. 116.
Perfumes, i. 117.
Perspiration, i. 202; ii. 2, 9, 19, 75, 133.
Petit's Canal, i. 81.
Physiological Action of Alcohol, ii. 123–155.
Physicians, ii. 126.
Pigment in the Skin, i. 190.
Pleasure, i. 140, 243.
Pliny on Jaundice, i. 120.
Poison, ii. 126.
Pores of Skin, i. 189.
Portal Vessel, i. 117.
Potato, i. 157.

Q.

Quack, i. 74.

R.

Rain, i. 52.
Rash on the Skin, i. 184.
Rays of Light, i. 84.
Reflex Action, i. 21.
Remedies for Headache, ii. 51.
  For Pain, i. 235.
Repairing Powers of the Body, ii. 57, 159.
Respiration, i. 246, 269.
Respirator, ii. 147, 199.
Rest of the Organs, i. 26; ii. 53.

Restlessness, i. 26.
Retina, i. 100.
Ringworm, i. 200.
Rooms, Ventilation of, i. 69, 266.

S.

Saliva, i. 154.
Sanguine Temperament, ii. 154.
Savages, How kindle Fires, ii. 117.
Scarf Skin, i. 219.
Science, ii. 157.
Sclerotic, The, i. 68.
Screw of Steamer, ii. 163.
Scurvy, ii. 204.
Sedentary Lives, i. 209.
Sensation, i. 9, 16, 215.
  Transmission of, i. 2.
Senses, where placed, i. 103.
Sensibility to Pain, i. 229.
Sewing Machines, ii. 190.
Shakspeare, i. 228.
  On Smell and Music, i. 119.
Shock, Death from, i. 235.
Shoddy Grinders, ii. 187.
Short Sight, i. 89.
Shower Bath, i. 213.
Sick, Food for, i. 142.
  Headache, i. 234.
Sight supplies Place of Touch, i. 222.
Sinews i. 183.
Skin, Functions of, i. 9; ii. 2.
  Organ of Sensation, i. 215.
Slate Pencil, Desire for, i. 142.
Sleep, ii. 53, 79.
Sleepiness from Drink, ii. 146.
Sleeping Rooms, i. 267.
Sleeplessness, ii. 80–92.
Smell recalls Memory, i. 115.
Snowballs, Danger of, i. 50.
Soap, i. 186.
Somnambulism, ii. 65–69.
Sounds, Loud, produce Deafness, i. 58.
Specks before Eyes, i. 206.
Spectacles, i. 89, 95.
Speech, Power of, i. 16, 19.
Speechlessness, ii. 227.
Spinal Cord, i. 6, 11.
Spirituous Liquors, ii. 126, 155.
Spongy Bone, The, i. 106.
Squinting, i. 76.
Starch, i. 158; ii. 160.
State and Individuals, ii. 126.
Steam Engine, ii. 158.
Steel Grinders, ii. 187.
Stiffness, i. 123.
Stimulants, i. 236; ii. 86, 145, 152.
  Use of, ii. 148.
Stoicism, i. 229.
Stomach, i. 161; ii. 132.
Strength, Adaptation of, i. 221.
Sugar, ii. 127.
Suicide, Craving for, i. 26.
Suppers, ii. 63.
Susceptibility to Pain, Different, i. 331.
Swallowing, i. 41.
Sweat Glands, i. 200.
Sympathetic Ganglion, i. 20.
Sympathy, ii. 3.
Syncope, ii. 147.
Syringing the Ear, i. 54.

T.

Tailors and Shoemakers, ii. 190.
Taking Cold, ii. 1–25.
Tape Worm, i. 121.
Taraxacum, ii. 124.
Taste, i. 127, 150.
Tears, i. 65.
Teething, i. 60.
Temperaments, Influence of Alcohol on different, ii. 183.
Temperature, ii. 132, 147.
Tendons, ii. 164.
Test of Alcohol in the Breath, ii. 133.
Throat, i. 130.
Tickling, i. 215.
Tissues under Alcohol, ii. 153.
Tongue, i. 149, 228.
Tonics, i. 210.
Toothache, i. 59.
Touch, Fundamental Sense, i. 217.
And Taste, i. 127, 224.
And Sight, i. 216.
Trainers, ii. 200, 204.
Training and Gymnastics, ii. 197–229.
Tumours, i. 121.
Turkish Bath, i. 208; ii. 24.
Tyndall, Prof., i. 43, 123.

U.

Unconscious Actions, i. 22, 29.

V.

Valve, Safety, i. 41.
Vapour Bath, i. 215.
Veins under Alcohol, ii. 132.
Ventilation, ii. 21, 93, 172.
Necessary Amount, i. 264.
Ventricles (of the Brain), i. 20.
Vermuth, ii. 155.
Vestibule of Ear, i. 45.
Villi of Intestine, ii. 131.
Vitus', St., Dance, ii. 224.

W.

Waking, ii. 72, 81.
Walking, ii. 173.
Warm Baths, i. 205.
Warmth, ii. 132.
Water not to enter the Ear, i. 55.
Pure, i. 298.
Watery Eye, i. 74, 76.
Weight, Sensation of, i. 219.
Wet Feet, ii. 19.
White Lead, ii. 192.
Wholesomeness of Food, i. 141.
Will, i. 16, 21.
Wilson, Geo., i. 120.
Windpipe, i. 253.
Winking, i. 100.
Work, Intellectual, i. 226.
Work-rooms, Unhealthy, i. 266.

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